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Terra

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Frogs & Toads





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Frogs & Toads, What are They?

by John W. Wright

photos by Roy W. McDiarmid

Frogs and toads, what are they? This question is asked almost as often as "What are the differences between frogs and toads?"

To begin with, frogs and toads have backbones and are therefore vertebrates. Since they have four feet, they are placed in the Tetrapoda, along with mammals, birds and reptiles. They are amphibians, but not necessarily amphibious. As they lack tails as adults, they are placed in the Order Anura (=tailless) of the Class Amphibia and are collectively called anurans or, more simply, frogs. There are only two other groups of living amphibians, the salamanders (Order Caudata=tailed) and caecilians (Order Apoda=legless).

Today there are approximately 2800 living species of anurans, arranged in some 285 genera. To make these numbers more meaningful, the anuran fauna of California consists of twenty species in six genera. In the continental United States, there are a total of eighty two species in eighteen genera. These aren't impressive numbers for such large areas; where are the remaining species of frogs found?

Most anurans are tropical with over eighty percent of the species occurring between the Tropics of Cancer and Capricorn. The diversity of anurans in the tropics is impressive. In an area of three km² near Santa Cecilia in Amazonian Ecuador, Martha Crump of the University of Kansas found eighty one species of anurans repre-

senting twenty five genera. The numbers of kinds of frogs in the temperate zones gradually decrease away from the tropics until only three species reach the Arctic Circle and none the Antarctic Circle.

The life cycle of a frog is so well known that just about any youngster of school age can recite the major components of the cycle. The males call from breeding sites in or near water, attracting females to the site; amplexus between the male and female takes place; eggs are deposited in the water by the female as the male releases sperm and fertilization takes place externally. The eggs hatch into tadpoles that eventually undergo metamorphosis to become froglets, which eventually mature to repeat the cycle.

Does this scenario hold true for non-temperate zone frogs? No, and by way of illustration, let's look at the eighty one species of anurans studied by Martha Crump. She found the following reproductive modes:

1. Eggs deposited in ditches, puddles, swamps, ponds, lakes and streams; tadpoles in water—thirty four species.
2. Eggs deposited in tree cavity above ground; tadpoles develop there—one species.
3. Eggs deposited in constructed basin of water on ground; tadpoles develop there—one species.
4. Eggs deposited on vegetation above water; tadpoles hatch and fall into water

Editor's Note

This issue of TERRA is an experiment. The idea for using the magazine to explore a single theme was broached more than a year ago. Toads and frogs were in the news, from articles about their California demise, stemming from commercial frogging operations to supply school biology and anatomy classes, to reports of kitten-sized toads in the Northern Territory of Australia going around gobbling insects that help maintain nature's delicate balance. The editorial board felt that exploration of some scientific aspects of toads and frogs, plus their unusually prolific and curious

place in history, literature, folklore, religion, and even medicine, would be a contribution to its readers. The magazine had to be expanded from its usual thirty two pages to forty eight; with time and money the subject would deserve three times that. There is no adequate way to thank Dr. John W. Wright, Curator of Herpetology at the Natural History Museum of Los Angeles County, for all of his work. He was indefatigable and cheerful throughout, despite wishing he'd known our direction in the beginning. (So do we). And thanks are due Dr. Robert L. Bezy, Associate Curator of Herpetology, for his aid in gathering and reading manuscripts.





Diaglena spatulata — La Cruz, Sinaloa, Mexico



Glossostoma aterrimum — Cariblanca, Costa Rica



Agalychnis callidryas — Osa Peninsula, Costa Rica

4

where they develop — fourteen species.

5. Eggs deposited in foam nest either on or near water; tadpoles develop in water — six species.

6. Eggs deposited on land; tadpoles carried to water by parent — development occurs in water — five species.

7. Eggs deposited in foam nest on land; tadpoles develop in nest — six species.

8. Eggs deposited out of water; direct development — fourteen species.

9. Eggs and young buried in skin pits on dorsum of female; direct development — aquatic — one species.

10. Eggs and young attached to dorsum of female by "gills"; direct development — terrestrial. One species.

11. Mode of reproduction unknown — three species.

Although this list of reproductive modes

is impressive, it does not include all of the modes known to be used by frogs. For example, live-bearing frogs are known where complete development occurs within the female and froglets are "born." There are other frogs that brood their eggs and tadpoles in their mouths and in one case brooding takes place in the stomach, where the eggs are swallowed and later small frogs are regurgitated. Contrary to common belief, parental care of eggs, larvae and/or young is widespread and relatively common in frogs.

Thus far, I have been able to present a great deal of information about frogs without discussing the question of what is a toad? This is perhaps how it should be, as this is largely a historical problem. Two groups of anurans are common in western Europe, members of the genera *Rana* and

Bufo, and there are vernacular names for members of each group in all of the western European languages: frogs and toads, English; ranas y sapos, Spanish; grenouilles et crapauds, French; etc.

As we are an English-speaking society, we have inherited frogs and toads and most commonly apply the terms to the members of the same genera as did our ancestors. Problems arise when attempts are made to apply these names, in an either/or fashion, to the broad spectrum of anurans occurring around the world.

There continues to be debate in the herpetological world as to how the names should be applied. Some would say that a toad is an obvious creature, as it has a dry, warty skin, spends most of its life away from water and is in general an ugly beast. Efforts to apply any of these criteria away



Rhinophrynus dorsalis — Tehuantepec,
Oaxaca, Mexico



Hyla ebraccata (male and female) —
Osa Peninsula, Costa Rica



Hyla rufitela — La Selva, Costa Rica

Atelopus varius — San Vito, Costa Rica



Eleutherodactylus weinlandi —
Dominican Republic





Anotheca spinosa — Costa Rica



Bufo mazatlanensis — Sinaloa, Mexico

Ceratophrys calcarata — northern South America

from western Europe have led to many inconsistencies where even members of the genus *Rana* would have to be called toads and some *Bufo* would be frogs.

When Linnaeus first established the now world-wide system of scientifically naming plants and animals, he used the Latin names for frogs and toads, *rana* and *bufo*. All of the frogs he knew were placed by him in the genus *Rana*. Fortunately the toads he recognized were to him little more than species of *Rana* (e.g. *Rana bufo*), perhaps establishing the first hierarchy for the two common names.

The late Doris Cochran of the Division of Amphibians and Reptiles of the Smithsonian Institution, after a thorough review of the subject concluded that a frog must have a parotoid gland (large poison glands between the head and shoulders, characteris-

tic of members of the genus *Bufo*) to be a toad.

In summary, all anurans are properly called frogs and a few of these frogs can be called toads; when this is permissible is still not clear. A general rule of thumb is that if you call a frog a toad and get no arguments, then it must be a toad.

In the pages that follow you will have the opportunity to catch glimpses of how anurans are viewed by a variety of people; from the standpoint of a naturalist-photographer; by anurologists, concentrating their study on certain tropical frogs; by conservationists, in one case concerned about the damage perpetrated by frogs and in the other the damage to frogs; and lastly from the standpoint of other cultures and the impact of frogs on their daily lives, religion, literature and art.

Dr. John W. Wright is Curator of Herpetology in the Natural History Museum of Los Angeles County. His primary interests lie in the ecology and evolution of reptiles and amphibians with an emphasis on evolutionary genetics.

California Anurans and their Adaptations



Fig. 1.
Western Spadefoot toad,
Scaphiopus hammondi a
common inhabitant of the Mojave Desert.

by **Nathan W. Cohen**

photos by the author

Before delving into the subject of California frogs and toads and their special adaptations, it is important to review amphibians in general and the problems they shared in coping with the environment during their long evolutionary history. To relate the occurrences, I find it fun and instructive to think of myself as a Methuselah-like amphibian, in this case an anuran, that came into being the moment the first fish-like amphibian ventured onto land. Obviously, I still exist; how else could I bear witness to the events that have transpired during the last four hundred million years?

Although we amphibians have tried repeatedly through the many generations of these millions of years, we have not found the key to success in this very different environment and many of us are still compelled to make annual pilgrimages back to our ancestral aquatic homeland. Perhaps this was our fault, however, as I must confess that we really ventured out onto land only to seek a more permanent body of water, as my old pond was drying up. Although we are the first "successful" land vertebrates on earth, our permeable skin required us to stay around cool damp places, and many of

us must return to the water to breed. But things aren't all bad; we do have mucous glands to help keep our skin moist and are thus able to venture out at least on short forays, especially on humid nights. And what do we find? As the only vertebrates on the face of the entire earth, we are freer of our earlier fears of aquatic predators, particularly the voracious fishes which abound in the pond. We also enjoy an abundance of food — all kinds of juicy insects and other arthropods — since no other vertebrates are around to compete with us for it. We like this land life! Let me tell you that life in the pond was no bed of roses — one eye out for predators while the other searched endlessly for food — I often went hungry! But on this warm marshy land! Wow! It is an unbelievable amphibian paradise (at least before it was replaced by the Garden of Eden, pesticides, and bulldozers!).

Although our moisture requirements did not allow us to venture very far, initially we amphibians thrived enormously well and, in a short time, became the dominant life-forms on earth. In fact, the current "rulers" of earth have named our glorious period "The Age of Amphibians." Alas, it did not last. Somewhere, somehow, some of our descendants, over millions of years,

evolved into reptiles — many of them quite fearsome and with appetites for the likes of me. These reptiles have a water-proof skin, covered by scales and a thick water-retaining covering over their eggs, thus allowing them to become less dependent on moisture and to spread out farther on land than we can. In this and other ways, they later became the masters of the earth.

Our descendants, the anurans or tailless amphibians, the salamanders or tailed amphibians and the caecilians or legless, worm-like amphibians are now but sad remnants of a once-mighty parade of amphibians who crawled, hopped, jumped or burrowed our way through a four hundred-million-year odyssey. During this time we amphibians adapted to everchanging climatic and topographic scenes, scenes in which we saw lush forests gradually fade into deserts or buried under ice as the glaciers waxed and waned during the Ice Ages. We also were buffeted about as lakes turned into marshes, and marshes became prairies, or worse for us, deserts. These geologic and climatic changes left untouched only a few small livable pockets isolated here and there over most of the earth by expanses of inhospitable terrain. In these pockets many of us thrived and



Fig. 2. Underside of a hind foot of the Western Spadefoot toad, *Scaphiopus hammondi*, showing the conspicuous "spade".



Fig. 3. Male tailed frogs, *Ascaphus truei*, have a conspicuous "tail".

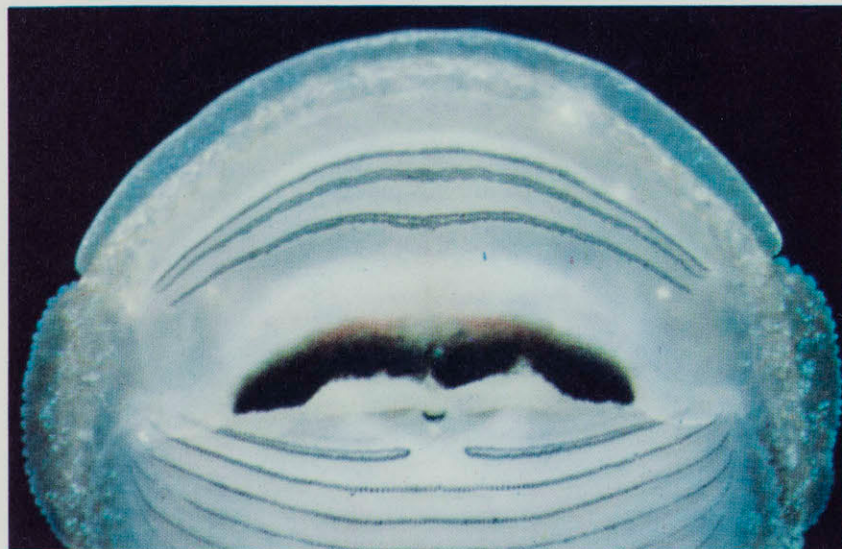


Fig. 4. The sucker-like disc surrounding the mouth of a tailed frog tadpole, *Ascaphus truei*. The disc is used as suction disc to anchor the tadpole to a rock while algae is scraped into the mouth with the sharp, black denticles or teeth.



Fig. 6. A heavy-bodied tadpole of *Rana catesbeiana*. This body shape is more characteristic of pond or slow water tadpoles.



Fig. 5. The slender, stream-lined, tadpole of the tailed frogs (*Ascaphus truei*). This body shape is characteristic of mountain stream tadpoles.

continued to prosper, some by evolving into new species, others by remaining as we were long ago. Because of all this, we still give the modern-day herpetologists untold headaches, as they try to unravel our history. In vain they try all sorts of ridiculous things — some quite inimicable to our privacy and health — measuring the length of our legs, the distance between our eyes, the webbing between our toes (how personal!), what our chromosomes look like (even I haven't seen my chromosomes — why should they?), — oh the list could go on and on, but that is their problem. We know who we are, even if they don't and frankly we don't see what concern it should be of theirs!

As my amphibian fantasy fades, I hope you will appreciate that the vision I present below is that of a herpetologist, but not necessarily that of a frog.

Many of the unusual behaviors and structures one sees in California frogs and toads are adaptations which allow them to make use of the very limited moisture that exists in many areas, particularly the desert areas. Frogs and toads, like all amphibians, are highly dependent on moisture for survival. The adults lack the freedom from dehydration afforded by scales and their derivatives (hair and feathers) possessed by other land vertebrates. Their gelatinous, unshelled eggs and their gilled tadpoles are usually totally restricted to aquatic environments. One might well ask how do some of these toads and other amphibians come to be isolated in small moist pockets in an otherwise hot and extremely dry desert. Surely they could not traverse such inhospitable expanses from distant mountains, even during a wet spring.

A number of years ago I was part of a group digging for some military hardware in the middle of the dry China Lake in the Mohave Desert. This dry lake is a huge, flat, treeless expanse, loaded with salts and bone-dry most of the year. Only with an occasional heavy rain will it accumulate a little water which usually lasts only a few weeks. I was astonished when we dug up a huge tusk of an ancient mammoth! Although we realized that China Lake was not always so dry and sterile, this startling find drove home with particular force the point that this forbidding place had once been quite lush, probably with an abundance of grass, trees, and water. At that time, the ancestors of the Mojave Desert species such as spadefoot toad and red-spotted toads would have enjoyed a wide distribution throughout the area. But as the climate became drier, the forests and grasslands faded to desert, the mammoths vanished,

and the frogs receded to canyons and other isolated places watered by underground springs and seepages. Here they continue to survive today. Let's look at some of our California species of frogs and toads, to see where and how they have been able to eke out a living in this increasingly dry land.

On the eastern edge of the Algodones sand dunes near the California-Mexico border, the western spadefoot toad (Fig. 1) manages to hang on in extremely arid areas by remaining deep under ground during hot, dry weather, sometimes holing up continuously for two years or more. The spadefoot is so named because on the underside of its hind feet is a sharp, horny, spade-shaped prominence (Fig. 2) by which the toad is able very quickly to dig itself backwards into the soil. Above ground, they avoid the rigors of the desert by being active only at night, when cooler air contains more moisture. In the desert habitat of the spadefoot, rainfall is not only scarce, but also very intermittent, and the pools formed quickly evaporate. To take advantage of these short-lived pools, the spadefoots must quickly gather in the water, deposit their eggs, which hatch into tadpoles and rapidly grow and metamorphose into the miniature adults which flee the now almost dry pool — all this in as little as seven days!

Another anuran which has remarkable adaptation to an unusual habitat is the tailed frog (Fig. 3). Herpetologists consider the tailed frog to be a descendant of the most primitive of frogs. This little anuran is only about an inch and half in body length and lives in high mountain streams in northern California, north through Oregon and Washington, perhaps into Canada. These mountain streams are noisy and treacherous as they rush with tremendous force over rocks and boulders and down steep slopes. Unlike most anurans, the tailed frog has no mating call. Instead of luring females to a breeding site with serenades, the male must crawl about on the bottom of the stream until it locates a mate. This frog also has evolved internal fertilization, a condition that is rare among anurans. This is an adaptation of the species to life in cold, swiftly-moving mountain streams, and is accomplished by a tail-like extension of the cloaca in males. If fertilization were external, as it is in most other anurans, sperm and eggs would be washed away before they came into contact. After fertilization, the eggs are laid in the water under stones, to which they are securely attached to protect them from the rampaging stream. To top it off, as soon as the tadpoles hatch, they attach themselves to



Fig. 7. Leopard frog, *Rana pipiens*, the commonly used laboratory frog.



Fig. 8. Pacific tree frog, *Hyla regilla*, one of the smallest species of frogs in the western United States.



Fig. 9. Western toad, *Bufo boreas*, the "garden toad" of the Pacific states.



Fig. 10. Colorado River toad, *Bufo alvarius*, the largest native anuran in the western United States.



Fig. 11. Juvenile red-spotted toad, *Bufo punctatus*.

rocks by means of a large sucker-like disc that surrounds their mouths (Fig. 4). By clinging to rocks they can scrape off and eat algae without being washed away. The tadpoles (Fig. 5) are generally dark in color but they have a characteristic small white spot on the tip of the tail, which is interpreted by some biologists as a protective device that focuses the attention of a potential predator on their tail rather than their body, thus increasing the larva's chances of escape. The tadpole, moreover, has a powerful, streamlined body and tail, quite unlike the sluggish, heavy-bodied, pond-dwelling tadpoles of other species (Fig. 6). There is fairly good correlation between the body shape of a tadpole and its habitat, streamlined tadpoles living in fast-moving water, plump ones in quiet water.

Practically all frogs and toads are endowed with two kinds of glands in their skin, mucous glands that keep the skin moist and poison glands that produce a toxin to protect the animals from predators. In most amphibians there tends to be a concentration of the poison glands along certain parts of the body. In toads, for instance, we find the poison glands generally concentrated in the so-called "warts" and particularly in the large glands on the neck called the paratoid glands. In most instances these animals will not excrete poison unless molested. The poison is usually white, sticky, with an acrid taste. In most cases the poison is merely distasteful and will usually induce the predator to drop its intended victim. In some species, however, as in the Colorado River toad, the poison is very potent and dogs have been known to die as a result of biting them. Although this poison is toxic if swallowed, one can handle any of these toads, including the Colorado River toad, with impunity, providing one's hands have no open wounds and the poison does not get into or onto a mucous membrane.

Adaptive coloration is a widespread phenomenon in many different kinds of animals throughout the world, taking so many forms as to defy the imagination — patterns which conceal, those which advertise an animal's presence, those which disguise, those which mimic other species, etc. Within each of these major kinds of color adaptation are an almost infinite number of variations. One adaptive coloration widespread in frogs and toads is called coincident disruptive coloration. Such coloration serves not only to visually break up the continuous surface of the body but also to join together distant parts of the body, thus reducing the chance of recognition by a predator. Such a pattern is seen particularly well in the hind limbs of several species of

California anurans. When its hind limbs are folded against the body, as in rest or in preparation to jump, the transverse dark and light patterns of the heel, calf, thigh, and body all coincide, thus tending to conceal the shape of the hind limbs. This can be seen in the leopard frog (Fig. 7), red-legged frog, yellow-legged frog, Pacific tree frog (Fig. 8), spadefoot toad, and California toad (Fig. 9). Should this disruptive coincident pattern fail to prevent detection, these animals can use their second line of defense, namely, jump or hop into the water, and failing to escape they will release the poison of their skin glands, which often will cause a predator to drop the victim. Of course, if the predator is a garter snake, which is not hindered by such poison, the victim usually becomes a meal.

Some frogs are adapted to an arboreal existence, climbing into shrubs and trees. One of these is the slim-waisted Pacific tree frog (Fig. 8), the smallest anuran in California, reaching a maximum total length of only three inches. It is an amazing experience to hear a loud raucous call along a stream, and to finally trace it to this tiny frog. On the tip of each of its fingers and toes is an expanded pad which serves as a combination suction and adhesive disc, enabling the frog to climb efficiently.

In contrast to the diminutive tree frog is the Colorado River toad (Fig. 10), our largest native anuran, reaching a body length of six inches. This large toad lives along the lower Colorado River and irrigated lowlands of Imperial County. Should this toad be molested, it may assume a butting pose and can squirt poison from the large paratoid poison glands which are just behind the eye. If swallowed in large enough quantities, this poison can paralyze and even kill a dog.

In addition to spadefoots, the red-spotted toad has been able to survive in the hot, dry Mohave and Colorado Deserts. During the breeding season, the mating call of the male is a perfectly charming and clear melodic trill, a pleasure to hear in the stillness of the desert night. Wherever there are streams, springs and seepages, especially in deep shady canyons, one can often find the tadpoles and the newly metamorphosed young (Fig. 11). The bright orange-red spots covering the back of the young toads make them surprisingly difficult to see as they hop on the red sand banks of the canyons. As the toads grow, their bright spots gradually fade as the adults take on the coloration and pattern of the granite boulders in whose crevices they hide (Fig. 12). So we see here a remarkable change in color and pattern from young to



Fig. 12. Adult red-spotted toad, *Bufo punctatus*.

Fig. 13. Black or Deep Springs toad, *Bufo exsul*, the geographically most highly restricted anuran in North America.



Fig. 14. Yosemite toad, *Bufo canorus*, a species restricted to the Sierra Nevada of California. Males and females of this species are strikingly dissimilar in coloration.

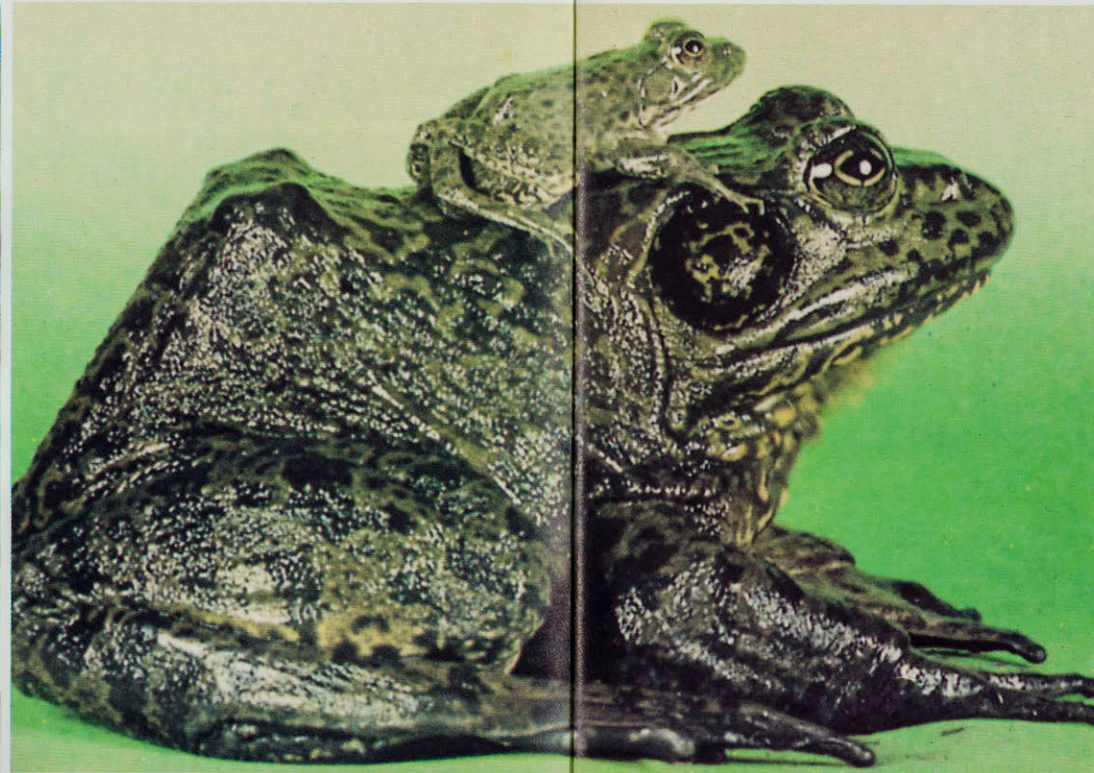


Fig. 15. An adult Bullfrog, *Rana catesbeiana*, with a newly metamorphosed juvenile on its back.



Fig. 16. Close-up of the head of a spotted frog, *Rana pretiosa*.

adults, corresponding to their change in life styles, not an uncommon pattern among different groups of animals.

The deep springs toad (also called the black toad, Fig. 13) is found only at Deep Springs (northeastern Inyo County), a grassy, spring-fed oasis surrounded by one "of the most forbidding desert areas in North America." The black toad is of particular interest because it has perhaps the most restricted range and the smallest population of any California frog or toad. For this reason, it is protected and has been declared rare and endangered by the California Department of Fish and Game.

In many animals, particularly birds, the sexes have strikingly different coloration, the male usually being the more colorful. In other groups of animals, including many amphibians, the sexes are not markedly different in appearance and are often difficult to distinguish. Among the anurans, there are some remarkable exceptions as the Yosemite toad (Fig. 14). Sexual differences in coloration are more pronounced in this species than in any other California anuran. Unlike most birds, however, it is the female Yosemite toad that is the more conspicuously marked, having large spots of black outlined with white and streaks of yellow and rust on her back, while the male is usually almost uniform dark olive green. In fact, the two sexes are so different in appearance that at one time herpetologists thought they were two different species!

The species of anuran that is most widely distributed in the state is the western toad, found from sea level to over ten thousand feet in elevation and living in a variety of habitats, from dry coastal valleys to forests. The western toad is the familiar "garden" toad and is possibly the most frequently encountered toad in California. Its wide range indicates that it is an ecological generalist. Some populations live in water that is distinctly saline, others occur around hot springs, and some in very dry situations far away from water. If I were to bet which species of anuran in California would most likely survive a severe and catastrophic change in the environment, I would place my money on this species.

Bullfrogs occur natively in the eastern United States and until the turn of the century were unknown in California. Between 1905 and about 1915, bullfrogs were introduced into the Sacramento and San Joaquin Valleys by people who wanted them to become established so that fresh frog legs would be available. Well, they became established all right. They became so well established that they now occur from the Pacific Coast to over three thousand feet in

elevation in the foothills of the Sierra Nevada and in nearly every fresh water habitat in California. And wherever they have moved in, via canals and other waterways, they have devoured and virtually eliminated our native anurans. Most herpetologists regard the bullfrog in the West as a most unwanted invader, destroying native frogs and toads wherever it goes. In its native habitat, the bullfrog tadpole may require as much as two years to metamorphose (Fig. 15). In the hot San Joaquin Valley and the adjacent Sierran foothills where bullfrogs abound in the innumerable man-made ponds, eggs laid in late March or April emerge as young metamorphosed bullfrogs in August, only four months later. Its large size is the key to its success, allowing an unlimited diet: all kinds of insects and other arthropods, fish, snakes, its own tadpoles and young, small, turtles, young alligators where they occur, ducklings, sparrows, swallows, brown towhees, mice, literally any living thing that it can swallow. The bullfrog is more of a threat to other low elevation frogs — the foothill yellow-legged frog, red-legged frog, and the leopard frog — than it is to high elevation species such as the Cascades frog, the spotted frog (Fig. 16), and the mountain yellow-legged frog.

Our rich and varied frog fauna is threatened not only by the introduction of other frogs, but by innumerable devastating environmental changes: urbanization, irrigation, declining water tables, dams, pesticides, draining of ponds, etc. While some of these changes are beneficial for some species, they all are harmful to most. Although anurans have been adapting to environmental changes for millions of years, the alterations occurring at the hand of man are too drastic, too far-reaching, and too rapid to allow anything but extinction for many species. Whether these species are saved from an early evolutionary death is ultimately up to you and me.

Dr. Nathan W. Cohen is Director of Curriculum Development in Science for the University of California Extension, Berkeley. His interests in Herpetology center on studies of the fauna of the Pacific Coast states.

About the cover

Ventral view of female *Centrolenella colymbiphyllum* showing transparent belly and heart, eggs, stomach, etc. Fig. 1.



Fig. 2. Lowland forest stream and the overhanging vegetation used as call sites by frogs of the genus *Centrolenella*.

Glass Frog Romance Along a Tropical Stream.

by Roy W. McDiarmid

photos by the author

To most people, the wet low-land forests of the Tropics connote an image of an impenetrable tangle of vines and other plants commonly described by Hollywood as a "jungle." A jungle to many brings to the mind deadly poisonous snakes, myriads of biting and stinging insects, blood drinking bats, and similar vermin too unpleasant to discuss, much less see. Yet these *tierras incognitas* have attracted many distinguished naturalists in the past, including such notable people as Alexander von Humboldt, Charles Darwin, Alfred Russel Wallace and Henry Walter Bates to name a few, and they continue to attract numerous botanists and zoologists today. Whether it

is the mating displays of brightly colored birds, the raiding columns of army ants on the march, or the intricate pollination systems of exotic orchids, most biologists are drawn to the Tropics by the lure of the unknown and their desire to study in nature, some of the most amazing and interesting organisms known.

Among the thousands of species of animals living in the tropical rainforests of the world, perhaps none are as interesting and diverse as the frogs. There are some frogs that live high in the tree tops and never come to ground, others that hop around in the leaf litter on the forest floor among the buttresses of giant trees, never venturing more than a few inches above the ground. Some species may weigh several pounds, while others weigh less than an ounce. A few are as big as dinner plates, others

smaller than a dime. Some tropical frogs are marked in contrasting colors of reds, greens, blacks and oranges; others are dull shades of brown or tan. Most put their eggs in the water where they hatch into tiny tadpoles. The tadpoles feed and grow in their aquatic environment, eventually changing into small froglets that grow into adults and repeat the cycle. There are many modifications of this better known reproductive pattern that are found in tropical frogs. Some species put their eggs on land where they develop and hatch into a small copy of the adults, completely bypassing the tadpole stage. Some species carry their eggs or tadpoles around on their backs, in pouches on their backs, in their mouths or, as was recently reported for an Australian frog, in their stomachs. It was some of these interesting aspects of frog biology that led

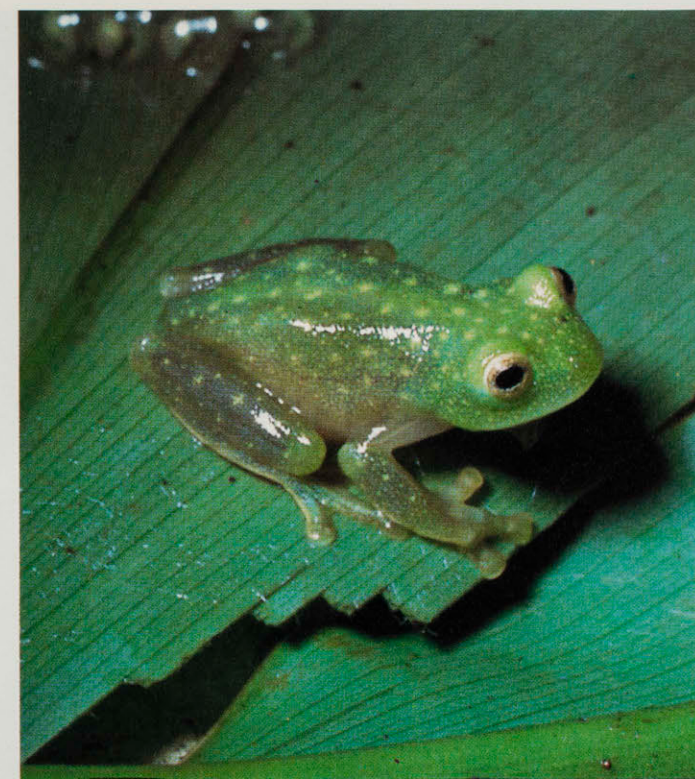


Fig. 3. Male *Centrolenella granulosa* sitting on leaf surface well above the stream.



Fig. 4. Male *Centrolenella fleischmanni* sitting on lower surface of a leaf above stream.

me into the lowland forests of Central America to learn more about the reproductive behavior and ecology of tropical species.

One of the more interesting groups restricted to the tropical forests of Central and South America are the glass frogs of the family Centrolenidae. These small emerald green frogs often have transparent bellies (Fig. 1) and green bones. They are nocturnal and restricted to the margins of small rivers and streams. During the rainy season as many as seven species of *Centrolenella* frogs may be heard calling along a stream flowing through the wet lowlands of Costa Rica (Fig. 2). Since all of the species are active at night, one must rely on a portable light to observe their behavior. I use a battery powered head lamp which not only provides adequate light but also frees my

hands to take pictures, make measurements, record their calls on a portable tape recorder and accomplish many of the other routine things required by this kind of a study. It is always best to scout a stream by daylight to locate all the particularly slippery rocks, deep pools, impassable logs and other hazards. Sometimes this is impossible and more often than not it results in an unexpected cold dunking.

The frogs are located by walking up a stream and listening for the vocalizations of males. These calls vary between species from high pitched bell-like "tink tink tink" and soft whistling "pseets" to relatively loud, fast "scree scree scree." Since the males call from leaves of plants along the stream from heights very near the water to over five meters above the stream, the localization of the calling males often is very

difficult. In densely vegetated sections of some streams I have spent more than an hour on several occasions trying to locate a single, sporadically calling male. Males of some species call from the upper surface of leaves (Fig. 3) and others call from beneath leaves (Fig. 4). Males of species that call from the lower surface are located more easily if their call sites are head high or higher; if they are calling from a site close to the water, one must get down on one's hands and knees, often in the water, to see the males. The reverse is true for those species that call from leaf tops. Clambering up steep banks or climbing small trees is often the only way to locate these males calling above eye level; those closer to the water are located more easily. The best nights to hear and see centrolenid frogs are during the dark phase of the moon during a



Fig. 5. Male *Centrolenella colymbiphyllum* asleep beneath a leaf well back from the stream.



Fig. 6. A female *Centrolenella prosoblepon* moving to the stream near a calling male.

light rain. This combination of conditions stimulates the males into active calling, sometimes lasting through the night. All males cease singing as the first light of dawn filters through the overhead forest canopy and lights the stream below. In some species the males pull in their legs, close their eyes, and spend the daylight hours on the same leaf they use as a call site. Others move back and up into the vegetation to more concealed sites (Fig. 5). As the day fades, they become active again. Many return to the same leaf used the previous night and commence calling with the arrival of darkness.

The calls of each species are distinct. The calls inform males of the same species where individuals are located and thus function to keep males spaced along the stream. The calling males also announce

their location to females for purposes of reproduction.

There is a minimum distance between calling sites within which males will not tolerate other calling males of their own species. On several occasions I have heard two males engage in calling bouts, apparently each trying to call louder and more often than his neighbor. These "shouting matches" may go on for two to three nights. Eventually one of the males abandons his calling site and moves to a new leaf at a greater distance from the other male where he resumes calling. The calls function to increase the dispersal of males along a stream and thus to reduce the amount of time males spend interacting with other males for a call site, and allow each to spend more time attracting females (Fig. 6). The females rarely are encountered except

when they come to the stream to mate. Apparently they spend most of their time in the forest, perhaps high in the canopy, feeding and producing their eggs. It is not known whether the females choose a male because of his song or choose a call site as a good place to deposit their eggs. I suspect both are important, perhaps the site being most important.

When a male successfully attracts a female to his leaf, he begins to give a different series of encounter vocalizations. These encounter calls, distinct from the previously described calls, are given only when another frog, usually a female, hops onto the calling male's site. After a series of calls and posturing movements, the male mounts the female in amplexus (Figs. 7 and 8). The frogs remain in amplexus for up to several hours, until the female begins to



Fig. 7. An amplexing pair of *Centrolenella colymbiphyllum*, showing smaller size of male.



Fig. 8. An amplexing pair of *Centrolenella albomaculata*.



Fig. 9. Male *Centrolenella valerioi* keeping a watchful eye on his eggs during the day. Males often sit with their hand resting on the edge of their clutch.

deposit her eggs. As the eggs are extruded, the male fertilizes them. The number of eggs in a clutch varies among species from about a dozen to as many as seventy-five. The eggs are encased in varying amounts of clear jelly and stick (Fig. 9) or hang (Fig. 10) from the leaf surface. After fertilization, the pair breaks amplexus and the female leaves the stream and returns to the forest. In some species the males have no interest in the developing eggs and leave the nest site to begin calling from another leaf in an attempt to attract additional females. In other species the males stay with the eggs day and night or leave the site during the day but return each night. Males of the latter species may attract up to seven females to a specific leaf and be found guarding (Fig. 11) the active clutches in varying stages of development.

The eggs develop on the leaf and after about two weeks begin to hatch (Fig. 12), often during a rain. The small tadpoles drop into the water below and seek shelter among the dead leaves and debris that often accumulate in the slow backwaters of the stream. Here they feed and grow much the same as tadpoles of our local frogs. Most of the Centrolenid tadpoles known are elongate and fiery red. After a period of several months during which time the tadpoles grow, develop hind legs and then front legs, and green color, they begin to metamorphose and crawl out of the water. It is not unusual to find tiny green froglets still with long tails sitting on a leaf at night along a stream. Soon the tail is absorbed completely, and the small frog begins to feed and grow eventually to take its place among the adults and repeat the reproduc-

tive process.

While egg laying and subsequent early development of tadpoles out of the water avoid some of the dangers of an aquatic existence, like storms which turn the streams into raging torrents or predation of these susceptible stages by aquatic insects and fish, hazards still exist. Even though the eggs are surrounded by a viscous, hydrophilic jelly, they are subject to desiccation should an untimely dry period develop. Predation and parasitism of the eggs are major problems. During the day, wasps and other predaceous insects eat the eggs or developing tadpoles or use them to provision their nests. At night the predator pressure is even greater. Small arboreal snakes, large centipedes, spiders, long-horned grasshoppers, ants and many other kinds of insects feed on the eggs and de-



Fig. 10. Well developed tadpoles in egg mass of *Centrolenella granulosa*. The egg mass is attached to the upper surface of the leaf but hangs over the leaf tip forming a drip tip to insure that water constantly bathes the developing tadpoles.



Fig. 11. Male *Centrolenella valerioi* guarding newest egg clutch. Jelly mass from old egg clutch remains for several days after the tadpoles have hatched.



Fig. 12. Egg mass of *Centrolenella pulverata* beginning to hatch.

veloping tadpoles. Occasionally the male and an entire clutch or clutches will disappear in a night, probably the result of a large predator such as a snake. Sometimes the attending male is able to protect his eggs from smaller predators, like ants, some spiders. This protective ability probably accounts for the differences in site tenacity and guarding behavior between the species of *Centrolenella*.

Walking up a tropical forest stream at night looking for glass frogs can be an exciting experience. In addition to learning about the love life of these beautiful frogs, you may have a chance to observe the foraging activity of some of the forest rodents or aquatic opossums that frequent the streamside habitats, or come across a column of army ants on a nightly emigra-

tion, or have the opportunity to watch the courtship behavior of long-horned grasshoppers. Most certainly you will see close at hand, several diurnal insects, frogs, lizards, snakes and birds asleep on leaves or branches along the stream.

The sights and sounds on a stream at night are very different from those during the day. Only the sound of the stream and raindrops on the leaves are the same. If your light does not burn out or the rain become too hard, you soon become completely engrossed in what is going on around you. More often than not, the unexpected will add to your experience. The unexpected and silent descent of a large spider on a thin silk thread from the canopy above, or the eerie glow of a bioluminescent fungus that appears when you turn out

your light in response to a feeling of being watched — all add to the experience. Do not let the swish of bat wings next to your ear or the occasional encounter with a large poisonous snake discourage you. If the opportunity ever presents itself, walk up a tropical forest stream some night. Maybe you will see a glass frog!

Dr. Roy W. McDiarmid is a Research Associate in Herpetology at the Natural History Museum of Los Angeles County Associate Professor of Biology at the University of South Florida in Tampa. His main research interests are involved with the study of the Neotropical herpetofauna, particularly frogs of Costa Rica.

Frogs Worthy of a Maiden's Kiss

Man traditionally has viewed frogs and toads as humourous ugly creatures endowed with magical powers; he has seldom considered them beautiful. Most frogs do conform, at least in appearance, to the traditional stereotype, but some tropical frogs, unknown to most North Americans and Europeans, rival tropical birds in the beauty of their coloration. The most spectacular are the tiny (one-half to two inches long) poison-arrow frogs, belonging to the genera *Dendrobates* and *Phylllobates* of the Family Dendrobatidae. You can see their fantastic colors and patterns in the beautiful

paintings by Joseph Nakanishi, staff artist of the Natural History Museum of Los Angeles County.

The thirty-six known species of poison-arrow frogs are found only in the New World tropics, from Nicaragua south to Perú, Bolivia, and Brazil. Most of them inhabit shady lowland rain forests, where they search the leaf litter on the forest floor for their principal food, tiny terrestrial ants. They are active mainly in the daytime. Although they can climb trees, they usually remain on or near the ground; they rarely enter flowing water.

Poison-arrow frogs are interesting not only for their coloration, but also for their unique life history. In North American frogs, the male attracts the female by calling and then seizes her in an embrace known as amplexus. During amplexus, the female lays eggs, usually in water, and the male fertilizes them externally. The parents usually desert the eggs. When the tadpoles hatch, they already inhabit an aquatic environment, in which they remain until they metamorphose into frogs. Until 1936, biologists thought that all frogs carry out amplexus. In that year, Walter Senfft, a skilled German terrarium enthusiast, published his observations on the breeding behavior of the Green Poison-arrow Frog (*Dendrobates auratus*). Senfft was the first man to observe the entire life cycle of a poison-arrow frog. He said that the Green Poison-arrow Frog does not practice amplexus; instead, the female goes alone to a leaf, where she lays the eggs. After the female departs, the male goes to the eggs, sits on them, and fertilizes them. Since Senfft's time, biologists have published observations on the behavior of several other species of poison-arrow frogs. The Granular Poison-arrow Frog (*Dendrobates granuliferus*) also lacks amplexus. During egg-laying and fertilization, the male and female face in opposite directions, with their rear ends touching each other. No one has witnessed amplexus in any species of poison-arrow frog; all species may lack amplexus.

The female poison-arrow frog lays her eggs on vegetation or on the ground. One (or both) of the parents guards the eggs. After the tadpoles hatch, they wriggle onto the back of their father (or, at least in some species, their mother), who carries them to a small, still body of water, such as the water in bromeliad leaf axils, in holes in trees, or even in man-made objects like oil-drums. The parent sits in the water; the tadpoles leave its back and complete their development in the water. This elaborate procedure probably protects the eggs from



Legendary dyer of parrots,
Dendrobates tinctorius
dominates this painting by
Joseph Nakanishi.

aquatic predators.

Poison-arrow frogs have an elaborate courtship; in *Dendrobates histrionicus* (called *kōkoé-pá* by the Chocó Indians), the courtship includes calling, pursuing, crouching, circling, touching, bowing, shaking, hugging, and sitting on the back.

Male poison-arrow frogs sometimes wrestle with other males of the same species, perhaps in defense of a territory.

Why are these frogs so brilliantly colored? Many biologists believe that the coloration of poison-arrow frogs is aposematic. Aposematic means warning; the word comes from two Greek words meaning "away signal." In theory, aposematic coloration protects the frogs from predators having color vision (mainly, diurnal birds). Most poison-arrow frogs are conspicuous in their native habitats. They have a poisonous skin secretion, which they release only under stress; the secretion is not toxic orally, but does taste bad. When seized by a predator, the frogs release their skin poison. The predator tastes the poison, releases the frog, and after several such experiences, associates the brilliant coloration with the bad taste, so that it will not again attack such a frog.

The secretions of poison-arrow frogs

vary in toxicity. I have introduced the poison of the *kōkoé-pá* into a small wound on my hand, with no adverse results other than a burning sensation. One species, however, *Phyllobates aurotaenia* (called *kōkoé* by the Chocó Indians), has the most toxic non-protein poison known (batrachotoxin). When injected subcutaneously into each mouse of an experimental group, only two millionths of a gram of this poison per kilogram of body weight per mouse kills half the group.

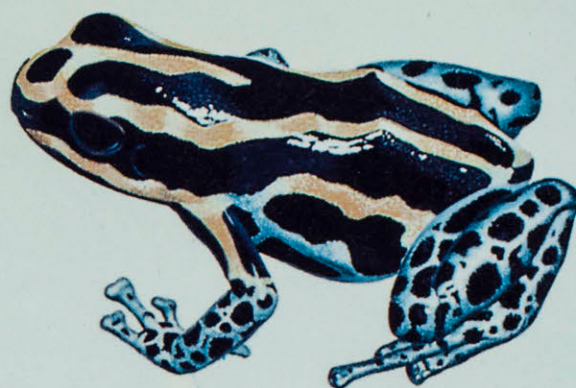
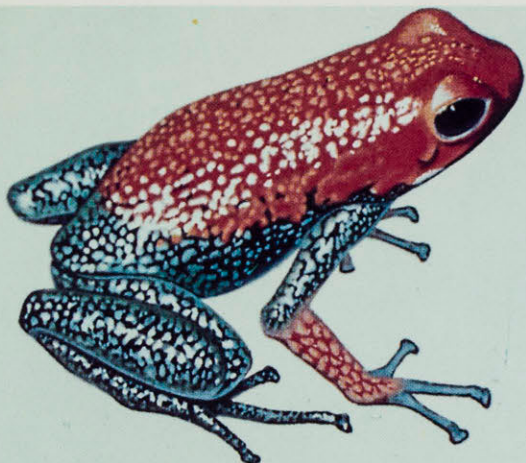
The Chocó Indians, who inhabit the Chocó region of western Colombia, use the *kōkoé* to poison their blowgun darts. The Indians find the *kōkoé* by imitating its call, whistling while tapping their cheeks. To make the *kōkoé* release its poison, the Indians pierce its body with a wooden skewer inserted through its mouth and sometimes hold it over a fire. The Indians poison the tips of their blowgun darts by tapping them on the back of the frog; the poison adheres to the spiral grooves in the tips of the darts.

The Dyeing Poison-arrow Frog (*Dendrobates tinctorius*), the largest of its family, is famous as one of the means by which the Indians of the Amazon drainage and the Guianas practiced *tapirage*, changing the color of the feathers of living parrots. Ac-

cording to the story (repeated in European literature since the sixteenth century), the Indians removed some of the green feathers of young parrots and rubbed the de-feathered area with the blood or skin toxin of *Dendrobates tinctorius*. The new feathers that grew after rubbing were red or yellow.

These venomous, strange-acting, demoniacally colored frogs seem the work of a sorcerer. Look again at their pictures, and remember that some frogs are worthy of a maiden's kiss.

Dr. Philip A. Silverstone is a Research Associate in Herpetology at the Natural History Museum of Los Angeles County. His research interests center on frogs of the family Dendrobatidae, with a recent emphasis on the ecology and behavior of Colombian species.



Six species of poison-arrow frogs, their glory incarnated by the brush of Joseph Nakanishi. Remember that they are only one-and-one-half to two inches long.





Man-made pond at Vasquez Rocks County Park, one of a number of sites in Southern California known to harbor the introduced African clawed frog (*Xenopus laevis*).

Exotic Visitor Becomes Permanent Resident

by James A. St. Amant

photos by the author

The Japanese weatherfish, *Misgurnus anguillicaudatus*, and the African clawed frog, *Xenopus laevis*, have one thing in common, although they are indigenous to distant parts of the world. They have found new homes in California.

In 1968 the weatherfish and clawed frog were both discovered in an Orange County Flood Control drainage ditch. Thus far the exotic weatherfish has not spread to other areas and does not appear to be a threat to native fauna; not so the aggressive, prolific African clawed frog.

In addition to spreading through the flood control system and other waters of Orange County, including some swimming pools, the frog is showing up in such widely separated areas as the Sweetwater River in San Diego County, the University of California Davis campus ponds near Sacramento, and Vasquez Rocks County Park ponds in

Los Angeles County. The spread of these frogs was undoubtedly enhanced by independent introductions.

The African clawed frog found its way to California following the discovery in the 1940's that it could be used in tests to determine pregnancy in women. It was soon learned, however, that the same results could be achieved with native frogs. Unfortunately, the clawed frog also proved to be an excellent research animal and laboratory demand continued. Also, aquarists found the largely aquatic clawed frog made an interesting addition to their collections and the demand arose from this quarter. But the aquarists also discovered that as the frogs grew larger, their diet included other inhabitants of the aquarium, and soon all that remained were fat frogs. Consequently, many clawed frogs were released into the nearest water available.

In general, introductions of exotic animals result in one of two things: the animals are unable to tolerate the new environment and fail to become established, or they flourish beyond expectation and pose direct threats to the native fauna. The best examples of deleterious introduction are the rabbits in Australia and the mongoose in Hawaii and the West Indies, but the amazingly rapid spread of the English sparrow and starling in our own country are good examples as well. The African clawed frog is no exception.

The presence of these frogs in Vasquez Rocks ponds poses a real threat to one of California's few native fishes, the unarmored three-spine stickleback, *Gasterosteus aculeatus williamsoni*, now listed as an endangered fish. Once found extensively in Southern California, they are now confined to one small section of the Santa

Clara River in northern Los Angeles County. The Vasquez Rocks ponds are located in the upper Agua Dulce Canyon which drains into the Santa Clara River.

Efforts to eliminate this threat by removing all the clawed frogs were undertaken by the California Department of Fish and Game in the spring of 1974 by chemically treating the ponds. These treatments continued through the fall until it appeared that the frogs in the ponds had been removed. Although the ponds offered an ideal situation for chemical treatment, repeated applications with various chemicals at extremely high concentrations were required to remove the frogs. This experience demonstrated that chemical eradication of the frogs would not be feasible in less ideal situations, such as large areas with dense plant growth.

In addition to their extremely high tolerance for toxic chemicals, the frogs were able to leave the treated water. An interesting phenomenon occurred following the first three treatments. Extensive reproduction took place, perhaps as a result of reduced competition. Tadpoles were extremely abundant possibly because of the limited number of the predaceous adult frogs that survived the treatment. Aquarium observations at this point indicate the most effective predators on clawed frogs are larger ones.

Hopes that the threat to the endangered sticklebacks had been eliminated by chemical treatment of the ponds disappeared in November, 1974, when forty juvenile and adult clawed frogs were captured in traps in the stream just below the ponds. Additional frogs were collected a month later in a pond below this area and closer to the Santa Clara River.

It appears now that the stickleback is in grave danger, unless we can find an effective method of eradicating the frogs.

So far, no clawed frogs have been found in the Santa Clara River; however, unless something is done, it is only a matter of time and the right circumstances before they will find their way into the river and the habitat of the endangered sticklebacks.

James A. St. Amant is an Associate Fisheries Biologist in the Inland Fisheries Branch of the California Department of Fish and Game. He is the Field Supervisor responsible for the management of fish, amphibian and reptile populations in Southern California.



Adult African clawed frog (*Xenopus laevis*) removed from Vasquez Rocks pond.



The distinctive, translucent, catfish-like tadpoles of the African clawed frog (*Xenopus laevis*).

A Visit with the Toad Lift Lady

by Elizabeth J. Wright

When these volunteers place the toads in the bucket or in the pond the toads may sing. However, during the big push across the road, no toad vocalizing is heard.



"Britain's Latest Crisis — Sex-Crazed Toads!" This blatant eroticism in our own Los Angeles Times? I checked. Yes, L. A. Times, March 7, 1974. Accompanying this shocking statement was an explicit photograph of a toad, mouth agape, eyes bulging, entitled, "Full of Lust". I read on. "Two hundred and twenty-four sex-frenzied toads squashed to death en route to breeding grounds." Could this Hollywood-biased reporting have something to do with conservation? "Miss Priscilla Oates, area representative for the Hertfordshire and Middlesex Trust for Nature Conservation, sounds a call for a volunteer bucket brigade to help swarms of sex-crazed toads cross the road safely to their mating place." So there it was — a mission of mercy featuring a Joan of Arc of toadodom.

It was apparent that a more profound investigation was in order. Therefore, a happy coincidence coupling a projected spring issue of TERRA to be devoted to frogs and toads, with a trip to England by the author, made the following report possible.

Preliminary correspondence with Miss Oates had set up the appointed meeting. Sunday morning, October 6, my husband and I found ourselves in Euston Station, breathlessly awaiting a train which would take us to Hemel Hempstead, Miss Oates, and the scene of the traumatized toads. The weather was perfect (for toads) — overcast and a bit drizzly.

A forty-five minute ride through salad-bowl green countryside brought us to suburban Hemel Hempstead. Awaiting our arrival was the cordial, dedicated Miss Oates who for two hours toured us through toad territory, transfixed us with statistical revelations and graciously provided afternoon tea.

Miss Oates quickly filled us in on the present toad dilemma. Pre-dating World War II, Hemel Hempstead was a watery Eden for the mating needs of the local amphibia. It had consisted of pasture land, on the traditional pattern of farm ponds, as well as innumerable village ponds. But then progress struck! Hemel Hempstead, which even now appears rural to the Southern California eye, became a planned community to accommodate the goal of decentralization. Flats arose, roads appeared, the sound of the bulldozer was heard in the land. Today, within a six-mile radius once punctuated with ponds, pools and other watering places, only one pond is left — the precious Pixie's Mere. It is here that the decimated numbers of *Bufo bufo* must make their way if they are to be fruitful and multiply.

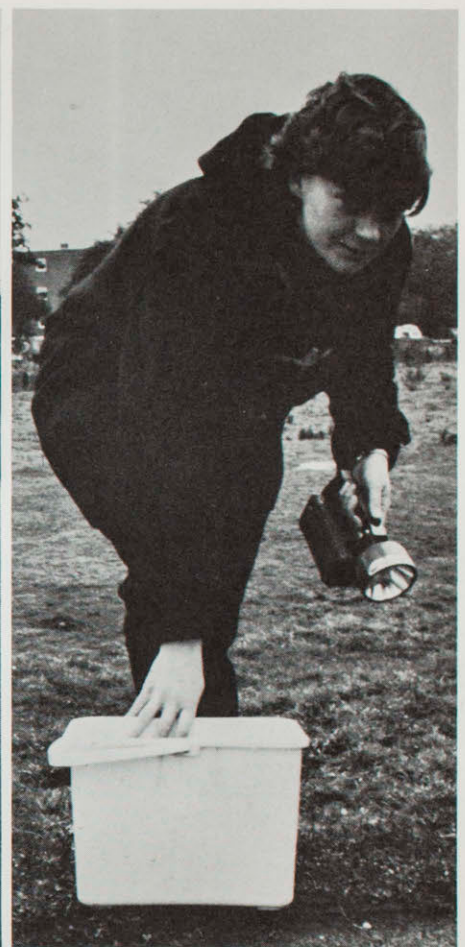
The serious threat to toad life at Hemel



Miss Oates indicating a seasonally-busy corner of Pixie's Mere.



A section of the London to Oxford road. Frogs hibernate in area to right then must cross road to breed in pond on left.



Miss Oates displaying frog lifting equipment.

The beautiful 6-acre Pixie's Mere, Hemel Hempstead's last pond.





Earth moving equipment a threat to Pixie's Mere.

Hempstead first became apparent in 1971. Cycling homeward one night a Mr. Norman Gamin, local ornithologist, experienced the horror of running over defunct toads littering the main road which runs from London to Oxford and parallels Pixie's Mere. (While traffic is nowhere near that of Los Angeles freeway magnitude, it had become sufficient to endanger the toad population at so critical a period in their lives.) Immediately Mr. Gamin alerted Miss Oates, head of the Rural Studies Department at Adeyfield School, and she threw her concern and expertise into the organization of the Hemel Hempstead Toad Lift.

Toad lifting takes place during March and April, mating months for the toads. Volunteers come from as far away as London, thirty miles distant. Other enthusiastic Lift members include students of Miss Oates, their parents, local farmers and nature lovers in general. The ages range from six to sixty.

The Toad Lift now boasts of approximately fifty volunteers who come during the two months — about a dozen at a time. Some make a joyous outing of the Lift. The delights of a picnic supper eaten beside a grass-flanked canal is heightened by the magic night sounds of coots, swans and *Bufo bufo* drifting in from the Mere.

Shortly after dusk one can expect to hear rustling in the undergrowth which signals the approach of the soon-to-mate toads. At times seemingly vast hoards can appear. At other times a very few. The first group appears about 7:30 followed by another group at 8:30. Then there occurs a gap until they start again about 10:30 with a final contingent showing at 11:30. It is during the gap that the nearby Three Horseshoe Pub experiences a brisk increase in business. So mutual an interest as toad lifting tends to quickly break staid British reserve and an immediate comradeship can develop. As one housewife volunteer exclaimed: "This is so much better than watching telly!"

The question arose: "Why in the world must toads be helped across the road? Can't they just quickly hop across?" We were firmly informed that toads are *not* frogs. Frogs hop. Toads crawl. In crossing the road a toad will crawl twelve steps, then rest. Another twelve steps . . . another rest . . . and so on until the street is traversed. In addition many females are weighted down with eggs.

Each volunteer keeps a tally. During 1974 approximately sixteen hundred toads were popped into buckets and transported across the road to the safety of Pixie's Mere. This marks a significant increase of

over the thousand mark achieved in 1973.

It is regrettable, but every worthwhile effort seems to suffer its villains and threats. During the Toad Lift at Hemel Hempstead, noxious, seasonal enemies spasmodically appear behind the wheels of motor cars. It seems unbelievable, but with deliberate malice they race back and forth, attempting to damage or kill the crossing amphibia. They also endanger volunteers, who receive small warning of their approach. It is because of this danger that youngsters under the age of sixteen must be accompanied by adults.

However, the most menacing threat has been the acquisition by a heavy equipment company of both Pixie's Mere and its adjoining acreage. During the day the company's massive bulldozers are at work in the surrounding countryside, but at night they grind their way along the Pixie Mere road and settle near waterside, unmindful of the migrating toads. More devastating is the knowledge that total destruction of the breeding place is imminent, as future plans call for the use of the beautiful Pixie's Mere as a dumping ground for the company's debris.

"It must not happen!" declares Miss Oates whose cry is echoed by ecology-minded residents who have girded for battle in an effort to save the last breeding spot of the local *Bufo bufo*. "For generations," Miss Oates declares, "toads have inhabited this area. Extremely important is their contribution to man in terms of biological control, especially the keeping down of rodent populations. Also, they should be preserved to acquaint future generations with fellow-inhabitants of the region. And what is not only vital but fair play is the right of toads as a living species to continue to exist!"

It was on this note that our visit concluded. We left Hemel Hempstead, our hearts disturbed but hopeful. As long as there is a Miss Priscilla Oates who will organize a Toad Lift, lead others through the damp darkness of night to gather and transport toads to their mating place, and who will fight for the right of *Bufo bufo* to continue to exist — all is not over for what British conservationists tellingly describe as "the usurped amphibia".

Elizabeth Wright has enriched TERRA with numerous articles. She has written comedy material for a quantity of Hollywood greats and in this bit of reporting her profession shows through. She has been published in numerous national magazines.

The compelling frog



The Toad of Death. From a French manuscript of the nineteenth century on the occult.

27

by William A. Emboden

*"Sweet are the uses of adversity
Which like the toad, ugly and
venomous,
Wears yet a precious jewel in
his head;"*

Anthony and Cleopatra II i:12
William Shakespeare

In the earliest writings in the English language the "Tode" and the "frogge" are frequently indistinguishable, and certain of these batrachians are almost biologically inseparable. The "ugly and venomous" toad was prized in Europe for an important reason — the widely held belief that in the head of the toad there was concealed a precious stone, and todestone could perform miraculous feats including removing poisons, healing, etc. Many stones were marketed as todestones (toadstones) being derived from any source other than the head of a toad. Soon this tradition changed into a specific stone — borax.

The toadstone or "*crapaudina*" was ascertained to be genuine if it was held before a toad and the toad leaped in an attempt to snatch the stone back again; it was said that toads envied men who had these in their possession. While the great scientist of the Middle Ages, Albertus Magnus, maintained that he had cut open many toads and not found such a stone, he believed them to exist and to be efficacious. Lore of the Middle Ages stated that the toad had to be lured with a scarlet red cloth, and while the loathsome creature disported himself upon this fabric, a stone will fall out of the middle of his head. Of course, a box with a hole in it had to be put under the creature so that when the stone fell it would drop into the box and not be sucked up again by the toad (as is their wont).

The oft-repeated story of obtaining the stone, by "bruising the animal in diverse places" and placing it in a crock of an ant hill to be devoured leaving only the bones and stone, dates to Thomas Lupton's *Book of Notable Things* (1660). Later writers calling the stone "batrachites" stated that it was efficacious for breaking stones in the bladder, against falling sickness, gripings and pains

of the belly. When touched to any poison, it will change color. In 1607 Topsell in his *Historie of Foure-footed Beastes* had already tried to obtain such a stone, and his lack of success led him to such skepticism that he addressed his reader stating: "I will referre him for his satisfaction unto a Toade, which he may easily every day kill."

But for the most part these peculiar batrachians were avoided, as it was believed that they "sweltered" under rocks exuding poisons from their warty skins. They were the embodiment of Satan, and Milton makes allusion to this in his epic poem *Paradise Lost* (IV: i 799), "Him there they found squat like a toad, close at the ear of Eve." That the creature was totally repugnant is evidenced by Shakespeare's frequent negative allusions to the amphibian. In *Othello* we encounter, "I had rather be a toad, and live upon the vapour of a dungeon, than keep a corner in the thing I love for other's use." Later (III ii 29) Othello laments his condition (thinking himself deceived by his beloved Desdemona), "The fountain from the which my current runs, or else dries up; to be discarded thence! Or keep it as a cistern for foul toads to knot and

gender in." Clearly, the lot of the toad was an unhappy one.

The genesis of most of the Old World folklore associated with the toad can be traced back to the shamanic tradition related by the theologian Mircea Eliade:

"According to Yakut tradition, the 'first shaman' possessed extraordinary power and, in his pride, refused to recognize the Supreme God of the Yakut. This shaman's body was made of a mass of snakes. God sent down fire to burn him, but a toad emerged from the flames; from this creature came the 'demons' who in their turn, supplied the Yakut with their outstanding shamans and shamanesses."

Possibly the earliest of all toad myths are Chinese in origin. In South China the toad was regarded as a diety at a very early date. During the Sung Dynasty the toad appears as a three-legged creature and is associated with the moon and fruitfulness. Often the figure of Liu Hai (who was supposed to have lived during the Sung Dynasty) is seen riding on the back of a large toad. This combination was emblematic of money and good fortune. This tradition of toad-diety was taken to Japan where the giant toad was sometimes depicted with a diety or shaman in his mouth. This oriental toad lore stands in strong contrast to most world myths concerning the toad with the peculiar exception of meso-America.

Mayan toad lore is extensive and was popular among the predecessors of the Aztecs and Mayas. Muriel Porter Weaver, who is an authority on these people, noted that the Olmec in San Lorenzo ate toads (among other things, such as dogs and people). The species they ate was most certainly *Bufo marinus*, the skin of which has been ascertained to contain bufotenine and most certainly provoked hallucinations. At Miraflores in Tomb I the toad was again encountered as a representation on stone mortars, pottery bowls, and as a motif frequently in relief on steles. In this same tomb there was found a "mushroom stone." Formerly thought to be the product of a cult of phallic worship, these stones are now known to be fairly common in Central America and represent cults centered around numerous genera of hallucinogenic fungi (*Stropharia*, *Conocybe*, *Psilocybe*, etc.) indigenous to Mexico. Ms. Porter notes that the mushroom effigies were made in preclassical times and after that their production ceased. In Guatemala there is still preserved in the museum a frog-toad altar in the round, indicative of the

significance of these creatures. Also, at Vera Cruz above the Pyramid of the Niches are palace-like structures with numerous toads in bas relief. In the Mayan language the toad was known as *xpek*, and in Yucatan the toad and the frog were both known under the name *much*. Zapotec names are *peche* (*peeche* or *breeche*), the toad being distinguished from the frog by the suffix *xeni*. Most frequently these people did not make the distinction, and the contemporary biologist frequently finds these distinctions difficult and not terribly significant. The god *Chac* is depicted as a toad-frog in the *Codex Cortes*. Most interesting is the three-legged toad appearing above the north altar at Copan; this animal, united with a fish allied with the earth-god, corresponds to the Chinese three-legged frog emblematic of good fortune, and so frequently depicted during the Sung Dynasty (960-1127). This unusual depiction and the association between the toad and the moon among the Mayan peoples adds further reinforcement to the hypothesis that there was an oriental influence among the Mayan people in pre-Columbian times. Jade found in some of the temple excavations could not have been mined in meso-America, and the oriental forms in some of the pottery goes unexplained. Now the toad reinforces a hypothesis that has been denounced by many anthropologists and archeologists.

The Aztec peoples associated the toad with *Quetzalcouatl*, the wind-god. The god-of-life also takes on the form of a toad. Due to the habit of the toad to burrow under things, the toad image may often be found on the underside of vessels. The venerable toad in one carving in the British Museum appears with a yoke about its neck, and in other depictions the toad appears on the yoke indicating the esteem in which it was held. The *Codex Cortes* depicts a toad and turtle swimming side by side. In the *Codex Borbonicus* the toad is metamorphosed into *Tlatteuctli*, the earth-god, and was indicative of 'unial, a twenty-day moon cycle and a twenty "hour" day. Eighteen "unials" made up a Mayan year. The toad is depicted with a glyph coming from its mouth indicating speech or sound. There are numerous correspondences between toad iconography among the Aztecs and Mayans which one would expect; more enigmatic are the Chinese elements.

Some characteristic South American toad myths depict the toad as owner of Fire (the Amazonia Bororo). When Fire is stolen by Sun (Meri) and his brother Moon (Ari), Toad rescues Fire and returns him to the Indian people. Likewise in the northeast Andes, the Chake and Mape tribes believe

that the stars gained their light by stealing it from Toad, owner of Fire. Among the Tupi shamans of south Brazil, the Toad Spirit may possess a shaman so that his behavior is characteristic of the movements of a toad.

In Honduras the Lenca maternal grandmother presents a toad to her grandchild at birth as a quasi-religious creature which is to be kept at hand at all times — even in bed; the loss of the toad foretells evil days.

In the beginning there was the toad, a rather powerful figure in the genesis of the whole tradition of shamans, magicians, sorcerers and deities. Why of all creatures was the humble toad chosen as so potent an animal diety? Its grotesque appearance would not be enough, and no one had really found a precious stone, or any stone, in the head of the toad. "Venomous toad" seems to be a clue. Certain toads of the genus *Bufo* contain in their skins a hallucinogenic principle known as bufotenine (which oddly enough was isolated from a "toadstool," *Amanita muscaria*, as well). Another toad common in Sonora (*Bufo alvarius*) contains the narcotic indole 5-methoxy-N, N-dimethyltryptamine. In the formulations of witches we know that the toad was an important ingredient, and woodcuts of the late fifteenth and sixteenth centuries depict the toad as an ingredient of those noxious brews. Perhaps the toad was one of the elements provoking the visions of witches. We know that certain plant materials which are hallucinogenic were included as well. The toad also appears on the ground around the gallows and in depictions of the crucifixion. Mention is frequently made of "The Great Toad of Death" giving us another iconographic symbol for the toad in the Old World.

A popular French folktale relates the story of a young man who was severely beaten by his father and left home. In the course of his travels he met a girl who was ill from possession by some evil force. His intuition took him to a millstone, which when lifted revealed a hideous toad squatting beneath it. He picked up the toad and cast it into a fire, at which time the spell was broken and the girl was well again. The villagers rejoicing in this made the boy a bishop. This story, like others, clearly implicates the toad in witchcraft and Satanism.

Among the peoples of Cambridgeshire in England there exists an abundance of toad legends in which the toad is always the familiar of a witch. There is an old Fen (Fenland being in east England) tale that a toad seen running for a dyke is a portent of rain. Another of these states that the Gauls navigated by placing the point of a dagger on



Witch conjuring up demons from Olaus
Magnus *Historia de Centibus*
Septentrionalibus, Rome, 1555

the wart of a toad's back, and these people assert that under such circumstances the toad will always point north. They also believed that toads gorged on glowworms could cure cancer when rubbed on the skin of the sick person.

"Toading" was synonymous with casting spells or performing witchcraft and was derived from an old Fen word "*tudding*." A witch could make herself (or a warlock, himself) invisible by mixing the spittle of a toad with the juice of the sow thistle (*Sonchus arvensis*) and making a crooked cross over the breast of her (him).

The "Toadsman" was a powerful male figure who was revered for his strange powers over animals, especially horses. Horses would stand still around a toadsman, as he was an ally of Satan having declared himself so by subjecting a toad to the aforementioned ant-eating and carry-

ing the bones about in his pocket.

Few Europeans would vindicate the toad until Kenneth Grahame in his delightful book *The Wind in the Willows* (Chapter X) presented the following bit of verse:

"The clever men at Oxford
Know all there is to be
known.
But none of them know half
as much
As intelligent Mr. Toad."

Even Mark Twain did not come to the rescue of the toad in repeating the popular neo-European myth that picking up a toad will give you warts. For all his work in eradicating insect pests in gardens, the toad has suffered enormous rebuff. Douglas William Jerrold in his vignette "A Chairitable Man" (*Wit and Opinions of Douglas Jerrold*, 1859) in speaking of a fine gentlemen stated, "He was so good he

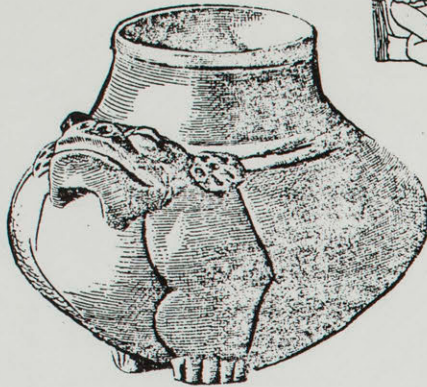
would pour rose water over a toad." Obvious charity must extend to the toad as well as other creatures.

In 1899 The American Folklore Society published a volume of superstitions among peoples of the United States, and scattered throughout this volume are the following allusions to toads and their peculiar qualities:

"Killing a toad makes the cows
go dry." Tennessee and Alabama.

"Killing toads or frogs in the
barnyard will make the cows
give bloody milk." Dor-
chester, and general in the
U.S.

"If you step on a toad your
grandmother will die."
Eastern Massachusetts
"If a toad crosses your path
it denotes disappointment."
Eastern New England



Death and the notables from *The Dance of Death* printed by Jacob Meydenbach in Mainz, 1492. The toad and serpent accompany death.

Toad Motifs:

Three legged Toad-Copan

Toad and man-Copan

Mayan toad ornamented (note glands)

Bufo Marinus pot from Guatemala (note glands)

Three views of a Mayan toad with yoke (British Museum)

Lower left: Tlateuctli (Aztec) *Codex*

Borbonicus

Lower right: Tamacallam (Aztec) *Codex* *Mendoza*

"If you kill a toad you'll stub your toe." Hingham, Massachusetts, Cape Cod, New Orleans.

"To find a toad in the water foretells a marriage." Negrolore (newspaper), no area (sic)

"Wish on the first toad you see hopping across your path in the spring." No area

"Kill a toad, and it will rain tomorrow." General in the U.S.

"Toads come out before rain." Lawrence, Kansas

"Bind a toad on a ring-bone on a horse for five or six days and it will cure it." Ohio

"Put a live toad into a box perforated with small holes,

and set it on an ant-hill. Leave it for several days, until the toad shall die and the ants clean the bones. Wrap the skeleton and put it under your pillow for three nights, and you will dream of your future husband." Winn, Me. (sic)

"Shut a toad in a box bored full of holes, place near an ant-hill, and leave it until the toad dies and the ants clean the bones. A certain hook-shaped bone is to be taken as a love charm. If this is fastened in the sleeve of a girl, she will marry you." Pennsylvania

It is obvious from the foregoing that the toad had a considerable importance in the

folk traditions of nineteenth century America. The one element uniting these stories and sayings is that of the power of the toad and/or its parts. The toad becomes capable of divination, malefaction, and a portent of good. This is not contradictory in a shamanic sense, as it indicates the essential state of good and bad in all things. Equilibrium is the essence of shamanism.

While Americans and the British have usually chosen to personify the toad as "Old Mister Toad," in native American Indian mythology the toad is usually assigned a female gender and frequently is "Toad Woman," a sort of supernatural being. Sometimes good and as often evil, Toad Woman is sometimes associated with the spectre of death and often tries to steal the life from youth. An example of the latter concept is a folktale of the Salishan Tribe (Washington state). The toad (*Smenap*) is



The public hanging of three witches in Chelmsford England in 1589. The three were Joan Prentice, Joan Cony and Joan Upney. The toad was one of the alter-egos of witches.

The sin of gluttony was punished by force-feeding the offender with toads and serpents. From *Le Grand Kalendrier et Compost des Bergiers*. Printed by Nicholas Le Rouge, Troyes, 1496.



Witches concocting "flying ointment" by Hans Baldung Grien, Strassburg, 1514.



always a woman of power.

"A woman was sitting in the doorway of her tent. Her long hair was hanging down over her face. A young man wished to see her face. When he inquired why she kept her hair down, she said that the sun hurt her eyes. At the same time she put her arms around him, holding him fast. He had to carry her wherever he went. After walking a long distance, he built a fire, and stood so near the fire, that her back blistered. Then her arms relaxed, and the youth cut off her hair. He saw that she had no eyes, no nose, no mouth, and looked like a skeleton. He threw her into a pond, and there she became a toad."

The Salishan people believed that if a person were foolish enough to eat a toad or portions of its body, it would either cause him to die or become covered with warts. These same people told a tale of the Moon inviting everybody to a feast in his house expecting Toad Woman. Angered, she made it rain in that house and in every place of shelter except her own. Finally the people came to her house to dry out. When Moon arrived, Toad Woman jumped upon the face of Moon and the rains ceased. Toad Woman did not come off the face of Moon and may be seen there yet. It is particularly interesting to note the strong relationship between the toad and the moon, which had an early history in China as well.

There is a fascinating toad myth among the Coeur D'Alene Indians which has been designated the "toad saviour myth" by Reichard who documented the tale in the *Memoirs of American Folklore* for 1947:

There was a chief of a village who had a grown daughter and a son who was merely a baby. Every morning the girl took the boy and other children away from the settlement to play. The Chief, angered by the girl's refusal to stay at home and become a woman, decided to punish her. All of the villagers were instructed to pull up their tipi poles and tents and go into holes in the ground (indicating animal alter-egos). When the girl and the other children returned, there was no settlement, so she cried and left looking for her parents. Soon they saw a house with a light, and the owner invited them to come in, but they were given no food. "Put down your little brother," said the owner, but the girl did not trust him and

refused. At night she heard the sound xuts, xuts, xuts, and thought, "He devours a lot of people." In the morning he asked the girl to help him make a pit for baking, and instructed her to go get leaves while he held the baby; she said that she would not let him go, but pulled together a big stack of leaves and grass. Dropping him for only a moment to put a big stack on her back, she spied a toad. The toad laughed and told her that she would die along with her brother unless every step she took was on the back of an animal and not on the ground. Then the toad became noble: "I am Toad. I am ugly, you are young and beautiful. I will die in your stead." She returned to the monster with the stack of leaves, her brother, and Toad on her back. The monster lined the fire pit with grass and put all of the children into it. The girl remained outside with her brother on her back. When the monster thought the children were cooked, he opened the oven-pit and found them uncooked and alive. Pushing them aside he found Toad. It was Toad who had caused the fire not to bake. The girl with her brother ran stepping only on the backs of animals and went from mountain to mountain until she was far away. The story teller ends by saying, "This is the end of my road."

The brother-sister-monster legend is a common story among the Nez Perce and Sahaptin Tribes as well. It certainly has parallels in the familiar European Hansel and Gretel story. The only disjunct element is the toad which appears in none of their other stories. It does, however, reoccur in a Seneca story.

The Seneca Indians have one of the few tales in which Toad is a male. It involves the pursuit of Younger, a magician, by a sorceress. The chase involves Younger taking on different forms, such as a stump, to elude the sorceress. He is also capable of making others appear to be him in order to confuse her. When he had all but exhausted his tricks, Old Man Toad appeared before him and addressed Younger as "My nephew" saying "Get on my back and bounce up and down. I will give a spring and throw you up on a smooth hill." This accomplished, Younger began to climb the slippery hill, but slid down into the den of an old woman who was boiling a pot of oil awaiting a visitor to cook. When Younger saw her he addressed her as "My Aunt," and she perceived his predicament. He was invited to hide above her bed. When the sorceress arrived, still in hot pursuit, the old woman told her that Younger was a great magician and had been able to go into the cauldron of boiling bear grease. At this moment the old woman, being something

of a magician herself, made the face of Younger appear in the bottom of the boiling cauldron. Seeing this the sorceress leaped in, and that was the end of her (although the story does go on, and Younger marries the old woman's daughter, has children, and finds his brother Older).

Once more the toad becomes a toad-saviour. The disproportionate size of the toad is characteristic of all fairy tales as is his remarkable abilities.

While the literature surrounding the toad is disparate, firewater, sun-moon-month, earth-wind-sky-rain, demon-god, saviour-malefactor, food-narcotic, etc., the totality of legends through the world indicate the toad to be of enormous importance in diverse cultures. The cross cultural similarities between toad motifs in Mayan and Chinese civilizations in pre-Columbian times must go unexplained, but reinforces the much-criticized concept that there was some contact between these peoples at a very early date.

The biological explanation for the popularity of the toad undoubtedly has much to do with its metamorphosis from an aquatic being, the tadpole, to a mature amphibian (often erroneously described as a reptile by those writing of the myths) with totally different form and behavior. The concept of disease and pestilence sometimes associated with the toad probably has its origins in the frequent appearance of "warts" on the skin of the creature (and in some areas the narcotic venom exuded in milky droplets from spongy external paratoid glands). To this author there is something intrinsically satisfying about the form of the toad; perhaps it has something to do with Jungian archetypes. This would certainly help explain its frequent appearance as an art object. But in trying to justify the creature to my reader, I will simply state that the toad is a most helpful creature contenting himself with a feast of noxious insects and "burping" nocturnal music that is a marvelous antidote to insomnia.

Noting William Emboden's proclivity for turning TERRA articles into books (three published so far) a fourth must not be far behind. Dr. Emboden is professor of biology at California State University, Northridge.

LEAPING BACKWARD

FROGS AND THEIR REPUTATIONS IN THE ANCIENT WORLD OF THE MEDITERRANEAN.

by Kilbee Brittain
Illustrations by Frank Page



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Frogs in the ancient world received mixed reviews, depending on whether their critics were Egyptian, Israelite, Greek, or other ancients. Several species of Family Ranidae were abundant in most Mediterranean lands, excepting the deserts, noisily recording themselves onto everyday human consciousness.

The most widely read publicity frogs have ever received is the second plague of the ten that Jehovah visited upon hard-hearted Pharaoh, who wouldn't let the Israelites go. The Old Testament Book of Exodus tells that "the Lord spake unto Moses, Go unto Pharaoh, and say unto him, Thus saith the Lord, Let my people go, that they may serve me. And if thou refuse to let them go, behold, I will smite all thy borders with frogs: And the river shall bring forth frogs abundantly, which shall go up and come into thine house, and into thy

bedchamber, and upon thy bed, and into the house of thy servants, and upon thy people, and into thine ovens, and into thy kneadingtroughs."

On Moses' instruction, Aaron held his rod up over the streams and rivers and ponds, and the frogs did just what they were told to do. Pharaoh begged Moses to make the frogs go away, "And the Lord did according to the word of Moses; and the frogs died out of the houses, out of the villages, and out of the fields. And they gathered them together upon heaps; and the land stank."

This story, based on events of perhaps 1250 B.C. at the royal city of Rameses which was northeast of present Cairo, is the delight of those who enjoy finding historical possibilities in biblical legend. In the first plague, the mighty Nile had turned to blood — perhaps the summer multiplication of tiny organisms in the swelling river similar

to the "red tide" afflicting Southern Californian beaches in August, or perhaps silt washed from sandstone during the flooding. The plague of frogs fits these seasonal hypotheses, since hordes of frogs often appear at the river's summer flooding. Mass emergences of frogs have been witnessed many times all over the world; considering that one female may lay five thousand or more eggs at breeding time, even if only a tenth survived the horde would seem a plague to all except hungry frog-eaters like the ibis.

The first three plagues — bloody water, frogs, and "lice" (gnats?) — were not really painful plagues, like the subsequent ones of flies and boils, but they were loathsome or disgusting. Frogs in one's bed or oven are not appealing, despite the Frog Prince or the thought of frogs' legs provençale. The Egyptians especially would have been

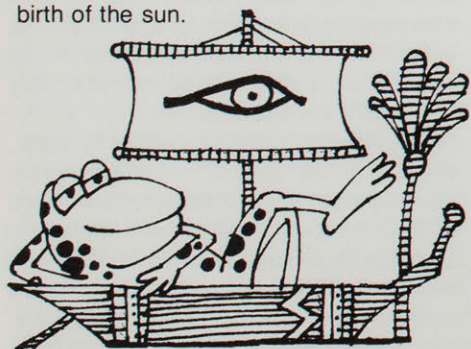
revolted at cold, damp frogs bouncing all over their eating utensils; they seem to have paid particular attention to kitchen cleanliness. Herodotus in his delightful description of Egypt around 500 B.C. wrote that the Egyptians did everything exactly the opposite of everyone else — they even washed their drinking cups every day.

The Israelites thought quite poorly of frogs (*zephardea*, from the word “to leap”), which in taxonomic chaos they lumped with creepers and crawlers and water animals without fins and scales like eels — in other words, abominations (Leviticus 11:10, 41-43). Certainly frogs were not to be eaten (Jews do not eat frogs to this day), and if possible they were to be avoided completely.

The decomposing bodies of the frogs would have attracted insect pests mentioned in the other plagues, which may well have spread diseases, leading a later psalmist to accuse the frogs of destroying the Egyptians (Psalm 78:45).

The worst part of the plague of frogs was not that they turned up in all the wrong places. The worst part was that they were obeying that foreign upstart Jehovah, thus insulting the Egyptian religion. From the time of the Old Kingdom (2700 B.C.) the frog was the symbol of Heket, goddess of creative forces and childbirth. One hieroglyphic text describes the creation of the world from a great abyss, after which Khnumu, the ram-headed god, and his frog-headed wife Heket, “the first gods who were at the beginning,” built men and made the gods.

Khnumu and Heket lived amongst the rocks of the first Cataract of the Nile (near the northern limit of the Aswan Dam and lake), thought to be the source of the Nile and even of all the waters of the earth. Nu, god of the watery abyss, also was occasionally pictured with a frog’s head, as were the four female and four male elements from which Creation was formed. Heket also symbolized one of the four lakes, part of the primeval ocean, from which the sun and the Nile were born. In fact, Heket was supposed to assist every morning at the birth of the sun.



When the Osiris myth became centered at Abydos and waxed powerful, Khnumu and Heket were mentally moved from the First Cataract to Abydos, to fuse the two myths into one wellspring of life.

Egyptian gods changed some functions and powers through the millennia, sometimes according to the power of the city where their cult was based; Heket was connected with different aspects of waters, creation, and birth at different times in the fluidity of religious thought.

Although some mummified frogs have been found in tombs, there is no real evidence that Egyptians actually worshipped frogs or considered them sacred, as they did cats and many other animals. The symbolic divinity does not seem to have been transferred to the actual frog.

Monuments to frog-headed Heket are found from the time of Queen Hatshepsut (1490 B.C.). On the temple terrace at Thebes there was a painted limestone carving of the smiling Royal Mother Ahmes being led to the birth colonnade by Khnumu and Heket. On the west wall of the Hall of Birth at a Luxor temple honoring King Amenophis III there is a sculpture of Heket holding a royal child and his *ka* in her arms; the Nile god stands behind them.

The frog does not receive the artistic recognition that his more comely brothers the cats, jackals, baboons, crocodiles and birds receive. A very early representation is a frog vase of carved limestone with bead and lapis lazuli inlay, thought to be Pre-Dynastic (before 3100 B.C.). An amusing stone frog was found in a Nag'el Deir grave along with an imitation of a Mesopotamian cylinder seal, perhaps indicating early trade between the two countries. One would expect to find frogs in the many lovely tomb paintings of Egyptians boating on the Nile or in lakes amidst fish, birds, lotus and papyrus and water lilies; I, for one, have not found them there. Perhaps they do not occur so often because the frog form, except when leaping, is not as distinctive or delightful as those animals with better defined features. One frog carved on a stele of Wepemnofret at Giza (twenty-sixth century B.C.) shows a round and lumpy form, not very interesting. In hieroglyphics the frog was a symbol for Heket, and the tadpole the sign for one hundred thousand. Some toad amulets survive; a Minoan small metal toad with lumpy warts on its back is displayed at the museum in Heraklion, Crete.

It may seem odd that so small an object as a frog should symbolize birth and even larger powers of creation in Egyptian religion. Yet consider the mysteriousness of the frog: able to live in the ruling waters, or in

the swampy marshlands or small ponds abundant then in the Nile Delta. Able also to appear seemingly from nothing and in great numbers; able to undergo miraculous transformations of form; able then to disappear beneath the waters. No wonder that the frog was a useful symbol for mysteries of creation from the primeval waters or from the maternal waters in utero.

Jehovah had showed his control over the River which controlled Egypt and over the religious symbol of creation and birth from those waters, to say nothing of his rebuking the Egyptians' considerable reptile worship.

Reverence for the waters and for the powers of the symbolic frog was widespread beyond the ancient Mediterranean. The world rests on the back of a frog, read legends of India, China, and Siberia; if the frog moves so much as a finger, dreadful earthquakes will shake the world. Considering the propensity of frogs for sudden leaps, believers must have slept poorly. An ancient Indian legend tells that only in the mouth of a frog would the Creator Turtle find mud to make the earth. Chinese legend has the handsome young divinity Han Hsiang riding in the sky on the back of a frog and carrying in a basket the peaches of immortality.

One story common to Africa and the Pacific blames the Flood on a great frog which swallowed all the water on earth. The animals were dying of thirst, and tried to make the frog spit out the water by making him laugh. They danced and danced, to no avail. But when the wriggling eel danced, the frog found the sight so ridiculous that he opened his cavernous mouth and croaked with laughter. The immediate enormous flood drowned many creatures, except for those saved by a pelican in a canoe. Folk humor enters also into countless other stories giving frogs a part in overwhelming events.

Reverence is replaced by aggravation or hatred in many ancient views of frogs. In Zoroastrianism, demonic frogs were spread through the world to cause blight, pain, and disease by Ahriman, god of darkness and death, whose most natural demonic form was frog-like. This mythology included warnings not to kill the three-headed demonic spirit or he would fill the world with frogs, toads, serpents, and other unholy objects; the demon was chained, instead.

A similar image occurs in the New Testament, in the Revelation of St. John, Chapter 16. Angels pour seven vials upon the earth. The sixth angel pours a vial into the Euphrates River, drying it up so the Kings of

the East may invade the Kingdom of the Beast — whereupon "I saw three unclean spirits like frogs come out of the mouth of the dragon, and out of the mouth of the beast, and out of the mouth of the false prophet. For they are the spirits of devils, working miracles which go forth unto the kings of the earth and the whole world, to gather them to the battle of that great day of God Almighty." These satanic frogs represent the last attack of the nations against the people of God. They are like the anti-Christ because they perform miracles, assembling all the kings of the world for Armageddon. After Christ's victory, the devil is not killed, but sealed in a bottomless pit for one thousand years.

The evil origin of frogs is repeated in many legends. Stories of Central Asia speak of a man-eating giant whose burned body split into fragments which became all sorts of destructive insects, frogs, and snails. Another tale has the devil poke a hole through the crust of the earth, frogs and other unwelcome animals popping out. Why frogs should be in the same unwelcome mess as pesky insects and harmful reptiles is a mystery; apparently most ancients did not distinguish between strange, helpful animals and strange, unhelpful ones.

There are many marvellous old stories about frogs all over the world, connecting them with man's mortality, with cooling rites and rain making (Frazer records that the Orinoco Indians keep frogs under pots and beat them when there is no rain), and with countless other aspects of daily life.

It took the Greeks to put a reasonable light on it all. They tell some tall tales about frogs, but, on the whole, their attitude was realistic, rational, and often humorous.

In the fourth century B.C. Aristotle wrote his great *Historia Animalium*, observing and describing animals with an accuracy and organization not found before his time. Although not quite solving the taxonomic puzzle, he understood that frogs live up to their amphibious way of life: "The frog, sea turtle, crocodile, hippo, seal, and tortoise choke or drown if they do not from time to time breathe atmospheric air: they breed and rear their young on dry land, or near the land, but they pass their lives in water."

This observant naturalist wrote that frogs live in marshes, copulate like other oviparous quadrupeds and viviparous animals (an erroneous observation), and have very small spleens. "The croaking frog has only recently appeared in the neighborhood of Cyrene," Aristotle wrote in a notation refreshing to read in our own age of shrinking habitats. Most remarkable to Aristotle was



ONE STORY COMMON TO AFRICA AND THE PACIFIC
BLAMES THE FLOOD ON A GREAT FROG WHICH
SWALLOWED ALL THE WATER ON EARTH.



ARISTOTLE: "FROGS IN A MARSH CATCH BEES."

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the frog's tongue, connected in front and unattached in back. This adaptation for securing insect food was interpreted by Aristotle as the means of the frogs' "peculiar croak," which he knew was how the male called the female to the muddy marriage bed.

But even the greatest naturalist can't get everything right all the time. Aristotle wrote that the frog croaks by putting its under jaw on a level with the surface of the water and by extending its upper jaw so that "the tension is so great the upper jaw becomes transparent, and the animal's eyes shine through the jaw like lamps; for, by the way, the commerce of the sexes takes place usually in the nighttime."

Aristotle included unusual information about frogs' preferred prey. Frogs in a marsh catch bees if the bees come to the waterside, he said, so beekeepers chase frogs away from ponds where bees drink. Aristotle said that the toad even comes to the doorway of a beehive, puffs himself out, and sits still, watching. As the bees fly out, the toad devours them. The bees can't retaliate, Aristotle remarked, but at least the beekeeper can. Modern naturalists might prefer to comment on the frogs' convenient choice of flies and mosquitos.

Many authorities believe the biblical and

most common frog of the ancient Mediterranean countries to have been the edible frog, *Rana esculanta*, common throughout Europe and the Middle East. One scholar states he hopes the Egyptians ate *Rana esculanta*, even if the Israelites weren't allowed to, but that they would have had to show agility to catch this good leaper. Aristotle implies that parts of frogs were eaten by his countrymen: he wrote that black formations attached to the starting point of the "teeth" were bitter to the taste and unfit for food. A blunt editorial note reads, "This must be the gut." Much of Aristotle's information was repeated in later Latin natural histories.

Aristotle's mostly sensible description of frogs is complemented by the silliness of frogs in many stories; the Greek sense of humor and their devotion to popping pompous balloons found the frog a handy comparison to humans. One of the very earliest animal poems (probably long before Aristotle's day) is a satire on the *Iliad*, a "Batrachomyomachy," a war between frogs and mice (a frequent theme in later fable, which turns up in a sixteenth-century European woodcut). It revolves around a one-day war instead of a ten-year Trojan war; the comic effect is in the reduction of everything to a small scale.

The mouse Pricharpax is abducted by

the Frog King, Physignathos. Going across the water, the king, frightened by a water snake, ducks under, and the mouse drowns. The mice declare war, and, as in the *Iliad*, the gods take sides. Zeus likes the mice at first, but since he must remain neutral he tells Athena to favor the mice since they visit her temples so much. Indeed not, says Athena, for they have eaten up her robes (a nice realistic touch). Nor will she help the frogs, whose croaking keeps her awake. The war proceeds with duels and long brave speeches, as in Homer. The terrible mouse Meridarpax gives his opponent frog a bad time until Zeus intervenes for the frogs, sending crabs that nip off the mice's legs and tails. The war is over.

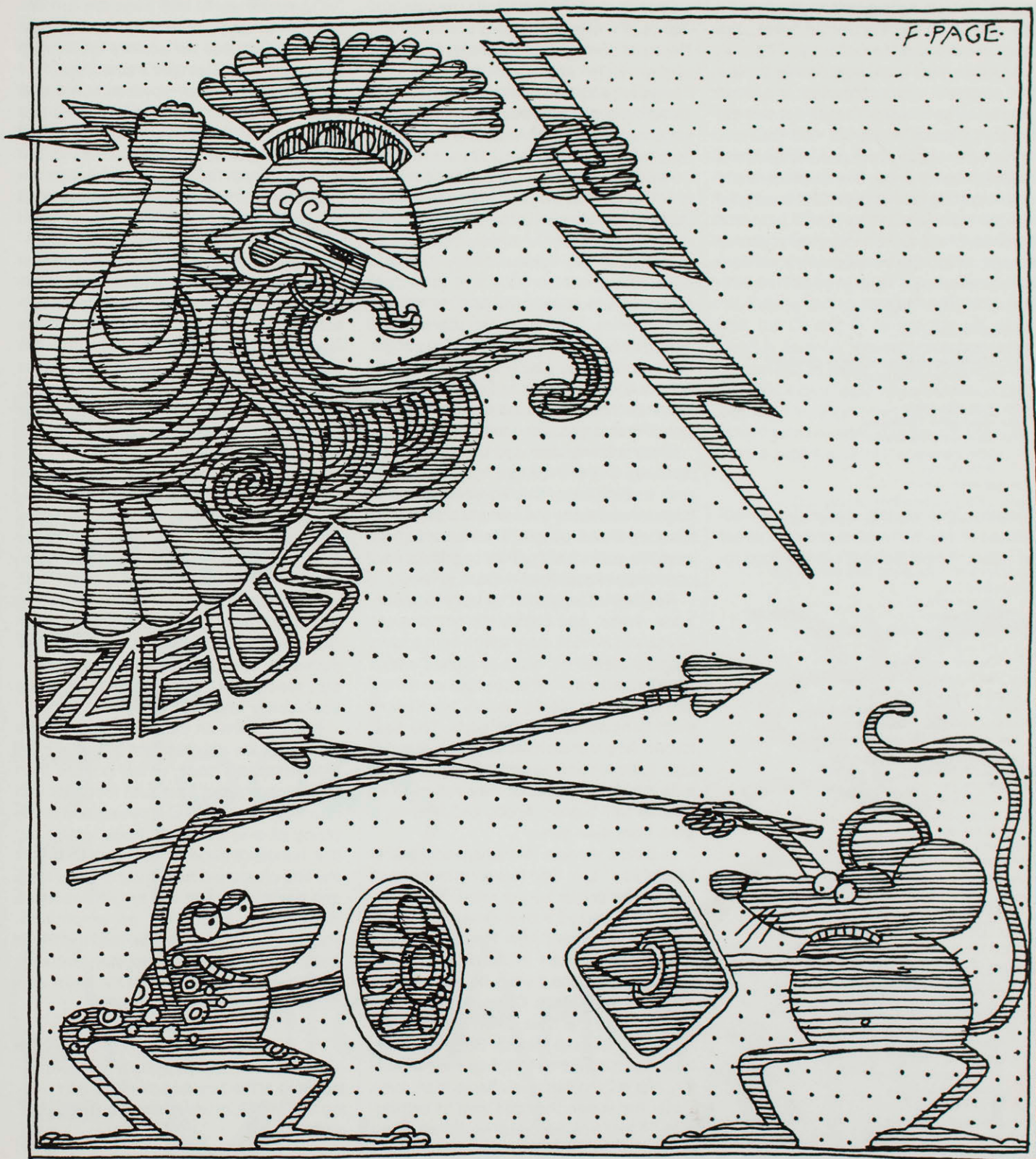
Greek fable contributes to a humorous view of man and his fellow animals. The fables typically tell an animal anecdote with a moral applicable to man. By the end of the fifth century B.C. most of the fables were attributed to Aesop, who lived a century before; later Latin fables usually derive from the Aesopian tradition.

Aesop tells a good number of frog stories. One tale tells that the hares were so afraid of their daily threat from men, dogs, eagles, and other predators that they ran to jump in a pond and die. The frogs heard them coming, and in fright jumped into the water. A smart hare stopped his suicidal friends, pointing out that the frogs were in worse torment of fear than they. There's always someone worse off than oneself.

In an often-repeated story, the frogs asked Zeus for a king. He sent them a block of wood which eventually the frogs just sat on and ridiculed. They asked Zeus again for a king. Zeus impatiently then sent them a water snake, which ate them all. (Variants of this story change the snake to frog-eating kinds of birds.) The moral: indolent rulers can be better than mischievous tyrants.

This story is reminiscent of the War between the Frogs and Mice: A frog played a mean trick on a land rat. He tied the rat's foot to his own and went jumping around, eventually leaping into a pond where the rat drowned. But the rat's body floated, holding the frog up on the water's surface. A kite swooped down and ate them both. Crimes are weighed in the balance.

Aesop also told that once a frog in a meadow was envious of an ox's great size. She swelled up and asked her children, "Now am I larger than the ox?" When they replied no again and again, she kept on swelling and puffing until she burst and died. In his *Satires*, Horace tells a variant, that a calf crushed all the frog babies except one, who told his mother about the huge beast. "This big?" she asked, puffing up



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A WAR BETWEEN FROGS AND MICE (A FREQUENT THEME IN LATER FABLE.)

and up. The young frog told her that even if she puffed up big enough to burst, she could never equal the calf's size.

Aristophanes was responsible for the first phonetic representation of animal sounds in *The Frogs*. The play, a satirical literary criticism written in 405 B.C., laments Athens' loss of poets, Aeschylus and Euripides being dead. Dionysus travels to Hades to bring back a poet. On his way, he and his slave are being rowed across a marsh by Charon when they hear a chorus of frogs, which the boatman says will help the unskilled pair keep proper time with their oars. The frogs say,

Brekekekex, koax, koax,
Shall the choristers of the marsh
Be censured and rejected as hoarse and harsh?
And their chromatic essays
Deprived of praise?
No, let us raise afresh
Our obstreperous Brekekekex;
The customary croak and cry
Of the creatures
At the theatres,
In their yearly revelry . . .

Dionysus, ignoring this slap at theatre audiences at his festivals, complains about the noise of the croaking, but the frogs reply,

We've a right,
We've a right,
And we croak at you for spite . . .
We've a right . . .
Day and night . . .
Still to creak and croak away.
Phoebus and every Grace
Admire and approve of the croaking race;
And the egregious guttural notes
That are gargled and warbled in their lyrical throats.
In reproof
Of your scorn
Mighty Pan
Nods his horn;
Beating time
To the rime
With his hoof,
With his hoof.
Persisting in our plan,
We proceed as we began,
Brekekekex
Koax, koax.

Dionysus, who by now has a blister on his bottom, complains again, but the frogs are unimpressed.

Cease with your profane entreaties
All in vain for ever striving:
Silence is against our natures.
With the vernal heat reviving,
Our aquatic crew repair
From their periodic sleep,
In the dark and chilly deep,
To the cheerful upper air;
Then we frolic here and there
All amidst the meadows fair;
Shady plants of asphodel,
Are the lodges where we dwell;
Chanting in the leafy bowers
All the livelong summer hours,
Till the sudden gusty showers
Send us headlong, helter skelter,
To the pool to seek for shelter . . .
Where, secure from toil and trouble,
With a tuneful hubble bubble,
Our symphonious accents flow.
Brekekekex, koax, koax.

Dionysus and the frogs argue on, Dionysus now suffering also from a sprain. The frogs don't care at all for his "fastidious foreign ear" and croak louder, until Dionysus beats them with his oar. The frogs are telling him that they defy him when Charon at last reaches the shore, and the passengers escape the raucous contest.

Aeschylus used a large chorus, even up to fifty, a number which would have made the frogs quite overwhelming on stage. One wonders whether the rowdy chorus was accompanied by the customary flute and harp. The characterization of the frogs, raucous, numerous, persistent, pompous, and at times describing themselves in a zoologically correct manner, is what people remember most about the play. "Brekekekex, koax, koax," may be one of the few lines those of us who took a course in Greek drama can still quote.

Other ancients also cast a critical eye on croaking. One of the satiric hymns of the Indian sacred poem, the *Rig-Veda*, sings of frogs awakened by the rain and able to bestow long life on people. Their croaking, so says the satire, is like that of priests who constantly repeat the Vedas.

Realistic observation of frogs' appearance, voice, and habits did not prevent Greek and Roman story tellers from adding magical elements, often in stories called transformations, in which people are turned into animals or plants, usually because of inept behavior toward the gods. The best known frog transformation is the story of Leto (Latona) who turned the Lycian peasants into frogs because they refused her and her twin babies, Apollo and Artemis, a drink from their lake.

In Ovid's version (*Metamorphoses* 6:4) Leto cries, "Live then forever in that lake of yours!" Her prayer was granted. The peasants were seized with a desire to plunge beneath the water; now they submerged themselves entirely in the depths of the pools, now popped their heads up, and swam on the surface. Often they rested on the banks of the lake, often sprang back again into its cool waters. But even then, their foul tongues still kept up their bickering, and with no sense of shame at all, even under the water, they still tried to be abusive. Their voices became harsh, their throats puffed and swollen, and their ill-natured croakings stretched their gaping mouths still wider. Their heads sank down onto their shoulders, for their necks seemed to have disappeared; their backs turned green and their bellies, the largest part of their bodies, were white. So they were changed into frogs, and, in their new shape, leaped about in the muddy pool."

Transformations into frogs are not unusual in other ancient folklore. Buddhist scripture tells that the penalty for stealing linen was to be changed into a frog.

Greek and Roman good-humored and fairly close observation of nature changed as the centuries passed toward more pseudo-scientific observation, as in the third century A.D. *Physiologus*, which includes the odd information that land frogs are not troubled by the heat and will die if rain touches them.

Magical attributes of frogs also increase. In the fourth century A.D. Marcellus of Bordeaux suggested this remedy for toothache: Standing under the open sky, catch a frog by the head, spit in its mouth, ask it to take the toothache away, and let it go. The frog assumes the function of scapegoat. It is an easy leap from his point to medieval Europe and its frog princes and frog magic, both good and evil.

Joseph Campbell in *The Hero With a Thousand Faces* calls the frog "The Little Dragon," the nursery counterpart of the underworld serpent. At least this gives frogs some status. But it would seem that ever since their better days in ancient Egypt when frog-headed Heket symbolized creation and birth, their reputation has been leaping backward. Unclean, silly, demonic, puffed up, noisy, companions of witches — they are due for a better press in our more ecologically appreciative age.

Numbers are on their side, however; at least frogs are still abundant in their ancient Mediterranean lands, which is more than the much praised lions and leopards can now say. Leaping and croaking and multiplying all over the earth, frogs remain our link, hundreds of millions of years past, with the first creature crawling out of the waters and breathing a first airy breath, leading a double life, becoming an amphibian. Perhaps ancient peoples sensed this about frogs — that they take the mystery of origins with them into the waters of the deep. And that's something to croak about.

Kilbee Brittain enjoys scholarly research, teaching at the Los Angeles Zoo, and writing for TERRA, of which she is an associate editor.

Frogs or toads, it is often difficult to tell which, are an ancient symbol. The frog-rain-fertility association has been found in so many early cultures that it has been suggested as a link from one to another.

In China, frog-like creatures are among the earliest zoomorphic motifs on neolithic pottery. There they sometimes appear as if swimming in a basin-like vessel called a *P'an*, painted in black slip on a fine buff earthenware body. Such pots, belonging to the Middle Yang-shao Culture (c. 2000-1500 B.C.), were excavated in 1924 at Ma-chia-yao in the western province of Kansu.

Anthropologists note that the frog-rain-fertility relationship also may be the basis for a pictogram, said to read "son frog," which was found on an early Chinese

bronze. Some believe this to be a reference to a once-common creation myth of descent from an ancestral frog and cite a similar belief surviving into the twentieth century among the Wa people of upper Burma.

The frog-toad is never a major symbol in Chinese art. Its most frequent appearance centers around Hsia Ma, often called the Toad in the Moon. In both China and Japan one sees in the full moon, not a man, but a hare or, occasionally, a three-legged toad. This toad, Hsia Ma, or Chan-chu, as he also is called, is said to swallow the moon during an eclipse and is the symbol of the unattainable and money making, an interesting combination.

Portrayed in bronze, porcelain and stone, Hsia Ma often appears with the fungus of immortality, *Ling chih*, sprouting from his forehead. *Ling chih* is a fungus, *Formes japonicus*, which grows on tree trunks and becomes woody and enduring. A common plant motif in Chinese art, *Ling chih* also appears conventionalized in a form known as the *Ju'i* scepter, which is used as a symbol of dignity. Sacred to both the Taoists and the Buddhists, this emblem is a favorite subject for jade pendants.

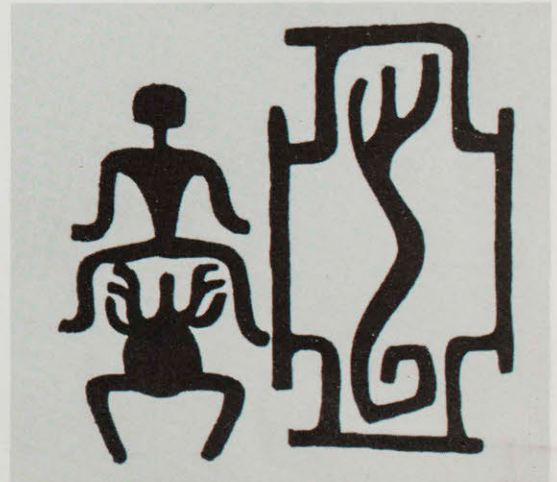
The toad, Hsia Ma, is often depicted alone but he is even more frequently associated with characters in one or the other of two legends, the tale of Liu-hai Hsien or that of the moon goddess, Ch'ang O.

In the myth which floats down to us from before the Han Dynasty, Ch'ang O married Shen I, an archer of such extraordinary ability that he shot down nine extra suns which threatened to scorch life from the earth with their heat. The Royal Queen of Heaven awarded him residence on the last sun to remain and offered him the Pill of Immortality. Shen I felt he needed a year of exercise and dieting before he dared such godliness, but Ch'ang O, finding the pill, swallowed it. Furious, Shen I threatened vengeance and in terror Ch'ang O flew to the luminous moon, cold and uninhabited except for cinnamon trees. Exhausted, she choked up the covering of the pill which became a rabbit as white as purest jade.

The woody and enduring *Ling chih* fungus, sketched here, is known for its long life and is the source for the design of the *Ju'i* scepter displayed by dignitaries and presented at weddings and birthdays.



The pictogram *tsi min*, read as 'son-frog', occupies the left side of this character found on an early Chinese bronze. It has been interpreted to allude to an early creation myth of descent from an ancestral frog. c. 1500-1000 BC.



Frogs & Toads in Oriental Art & Myth

by Sage Culpepper Belt



The Chinese hermit Liu-hai Hsien with his companion, the three-legged toad Ha-ma, is known in Japan as either Gama Sennin or Kosensei. Yen Hui (14th c. AD), Ink and color on silk, Chionji, Kyoto.

Despite her fickle misdeed, Shen I's love for Ch'ang O was such that he built her the Palace of the Great Cold on the moon decorated with precious stones and pillars of cinnamon. There he visits her on the fifteenth day of each month, a fact which accounts for the unusual brilliance of the moon at this time.

On the sun he built for himself the Palace of the Lonely Park and from that time the sun and the moon both had their ruling sovereigns. Shen I and Ch'ang O are often represented, he holding the sun, she the moon. Some legends say that she was changed into the three legged toad, Chan-chu (or Hsia Ma) visible on the surface of the moon.

This story is still a favorite of Chinese craftsmen who depict Ch'ang O and Chan-chu on the moon disc, accompanied by a white hare grinding the elixir of immortality and seated under the cinnamon tree. Japanese lore also similarly mentions Chan-chu as the Frog in the Moon where he appears with the white tiger, *tora*, and *usagi*, the hare, an emblem of longevity which is reputed to derive its origin from the vital essence of the moon.

The second story of the three-legged toad concerns its relation with an immortal, Liu-hai Hsien, a solitary man of the mountains. Immortals, or *hsien* as the Chinese call them, are hermits who seek everlasting life through the teachings of Taoism. The three-legged toad is the legendary messenger of Liu-hai who is usually shown holding in his hand a cord, the end of which is attached to the toad. Across his shoulders Liu-hai often wears a curious garland of golden coins and eggs, a reference to an event in his previous life as minister to a powerful overlord. Liu-hai and his toad Chan-chu are included in the category One Hundred Precious Objects.

Liu-hai also appears in Japan where he is called either Gama Sennin or Kosensei. Gama refers to toad and a sennin is one dedicated to meditation and asceticism. Kosensei means Teacher Ko. Gama Sennin wears a skirt or a kilt of large leaves and is portrayed with a smiling face, disheveled hair, barefoot and with a toad, either three or four-legged. In one version of the tale of Kosensei, he is said to be able to assume a toad shape when in the water and to put his magical knowledge to use by selling drugs endowed with wonderful powers.

Craftsmen sometimes depict him in the act of giving the Pill of Longevity to a toad or frog.

In contrast to Chinese art where they seem to be one of the rarer motifs, frogs, depicted in delightful variety, appear frequently in the art of Japan. One outstanding example is the Scroll of the Frolicking Animals painted in the late twelfth or early thirteenth century and preserved in the Kozan-ji Monastery near Kyoto. This scroll, associated with the name of the Buddhist priest Toba Sojo, seems to be a gentle satire of monastic and everyday activity, with frogs and monkeys, rabbits and other animals cavorting and behaving as humans, wrestling, swimming, racing or, more soberly, worshipping a great frog sitting as Buddha solemnly enthroned against a banana-leaf halo. Such themes still appear in paintings and woodcuts.

A favorite theme in Japanese art, that of animals masquerading as humans, is illustrated in a detail by the artist Rinsei of frogs carrying lotus leaves and cat-tails. It is from a larger work with painting and calligraphy by a number of artists celebrating a literary gathering. 1875. Private Coll.

Enthroned as Buddha, a giant frog is solemnly worshipped by monkeys garbed as monks in this gentle satire of monastic life. Attributed to Toba Sojo, 12th-13th centuries. Scroll of the Frolicking Animals, Kozan-ji Monastery near Kyoto.



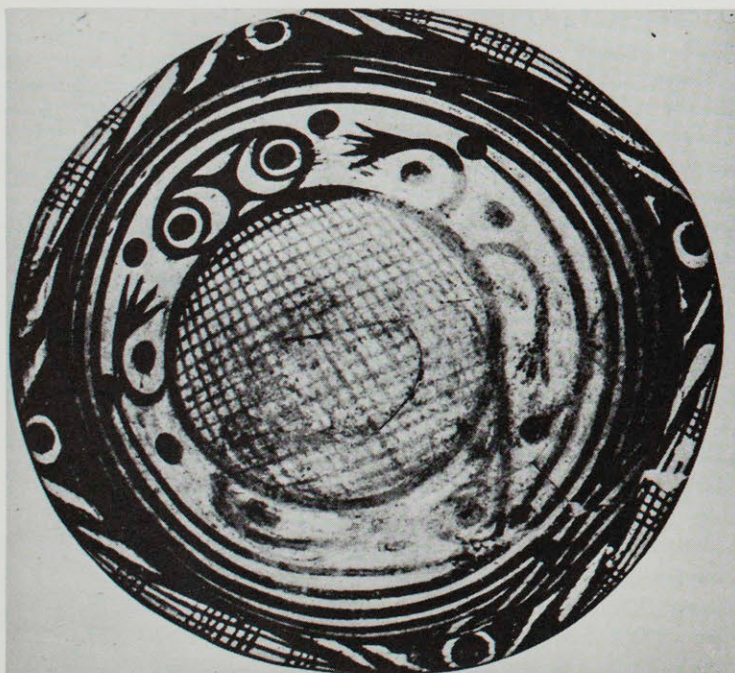
Cavorting and behaving as humans, frogs and rabbits wrestle in a humorous early scroll attributed to the monk Toba Sojo. Scroll of the Frolicking Animals, 12th-13th century, Kozan-ji Monastery near Kyoto.



Netsuke frog resting on a lotus leaf, carved wood by Yoshigetsu, Japanese, mid-late 19th century. Los Angeles County Museum of Art collection, gift of Mrs. G.W. Mead. LACMA photo.



Frog-like creatures are among the earliest zoomorphic motifs to appear on Chinese neolithic pottery. Middle Yang-shao Culture, Kansu. Ostasiatiska Musset, Stockholm.



Frogs just as frogs also occur in the art of Japan. They are favorites with the carvers of *netsuke* and one often finds carvings of a mother frog, baby on her back, squatting on a straw sandle or basking on a lotus leaf.

Toads also appear in connection with a number of Japanese legends. One popular allegory *San Sukumi*, the Three Cringing Ones, seems designed to teach the lesson of interdependence. This group consists of a toad, a snail and a snake who fear one another because it is believed that each can destroy one of the others; the snake can swallow the toad, the toad can swallow the snail and the slimy secretion of the snail is fatal to the snake.

Another legend tells of Ono no Tofu, a celebrated calligrapher and public servant, who learned the virtues of perseverance by watching a tiny frog trying to catch a willow leaf dangling over a stream. Ono no Tofu is often represented in the garb of a nobleman and is accompanied by the frog from whom he learned persistence. They sometimes appear on the cover of children's school books.

The ancient Japanese believed that the toad was a mysterious being who travelled everywhere and was well informed. Perhaps this all-knowing quality is the reason the toad is included as the companion of the Woman of the Three Road River, a river reminiscent of the River Styx in western legend. She was associated with

Emma O, the Regent of Hell, and was a favorite with carvers who show her with the toad sitting on her knee.

Never a major symbol such as the tortoise or the dragon, these amphibians are still an important oriental emblem. In China, for countless centuries frog-spirits have been worshipped for commercial prosperity and for the prevention and curing of disease.

This association with health is especially interesting in view of the uses in Chinese medicine for *Ch'an Su*, a powder made from the slimy secretion gathered from the skin of the toad, *Bufo asiaticus*. *Ch'an Su* contains Bufotenin, a cardioactive alkaloid which is somewhat like digitalis in its effect upon the body, causing elevation of blood pressure through a strong and lasting constriction of the blood vessels.

Several methods are mentioned in the collection of *Ch'an Su*. Since the toad secretes this substance in response to stress, the collector sometimes burns or pricks him near the eyes or places him in a jar whose cover is studded with bamboo needles.

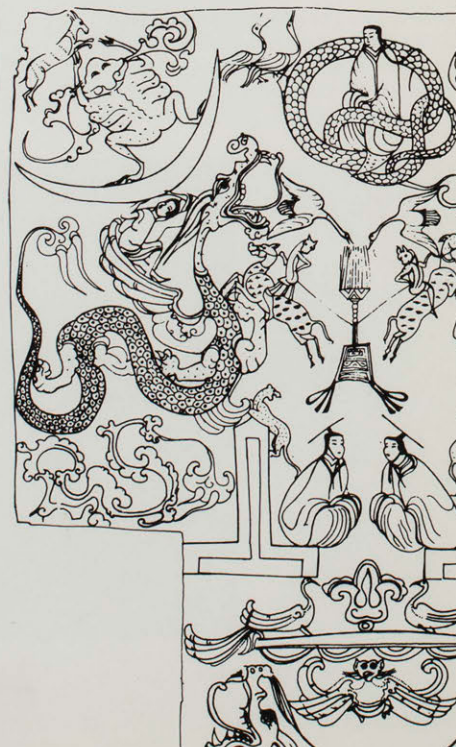
Fear or intimidation also cause the toad to secrete the liquid; thus, another effort at collection is to surround the toad with glass mirrors in an effort to frighten him. Whatever method used, the liquid material is collected, dried and mixed with flour and other ingredients into cakes to prepare it for the market. In addition to treating heart problems, it is prescribed for boils, dog bites, abscesses and ulcers. Perhaps, therefore there is a connection between the value the Chinese place on *Ch'an Su* as a beneficial drug and the fact that the toad, its source, is a symbol of health.

Thus, along with allusions to popular folk tales and legends, frog-like creatures present a constellation of association: health (even in Japan where the goddess of fevers, Karu, carries a yellow toad on her shoulder), luck and good fortune; the moon, rain and fertility. Amusing and irrepressible at times, they are also mysterious and all-knowing. They can change shape at will and their alliance with things immortal makes it appropriate to end with a recipe for the Pill of Immortality. It is from the Taoist *Ko Hung* (400 A.D.) and begins:

"Take three pounds of cinnabar and one pound of white honey. Mix well, dry in the sun and fashion into pills the size of a hemp seed. Take ten pills each morning for a year. White hair will become black again, decayed teeth sound, the old will become young and never die."

Sage Culpepper Belt teaches History of Ceramics at various universities and writes on a wide variety of subjects related to art history and ethno-botany.

Detail of painted silk funeral banner, placed on the coffin of the Marquess of Tai, showing "toad as man in the moon" motif. Han period.



Frogs, such as this mother with her baby, are a popular subject for the netsuke carvers of Japan. Wood, undated. Private coll.



MUSICIANS OF THE CHAC

by Gretchen Sibley



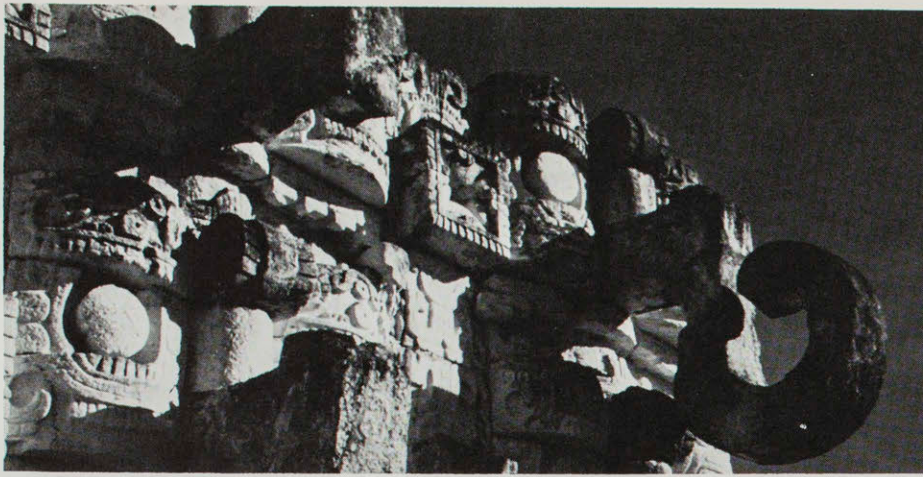
Red pottery frog vessel from Colima, Mexico. Armando Solis, photographer

Black ant was the first to bring out grains of corn stored under a mountain of stone. Animals tried this new food and soon man learned of it, but only the ant could reach it. Man prayed that Chac, the rain gods, would break open the mountain. Again and again the gods tried with all the force of great storms but failed. Finally the Great Chac, chief of the rain gods, was persuaded to try. Wisely he asked the woodpecker to peck away at the mountain to find the weakest spot in the rock. At this spot Chac hurled his greatest thunderbolt which tore open the mountain and released the corn. But the woodpecker was injured and to this day bears a spot of blood on its head. Thus Chac became the greatest god for he gave to man his greatest gift.

The Chac were important in Meso-America before gods of the Sun and Moon were recognized. The people connected these water gods as the highest beings in control of nature: water, clouds, lightning, thunder, earth, heavens, plants and animals. Without the Chac there would be no corn, the single important food and economic item in their lives. Corn was so important that everything related to the growing and use of corn was wrapped in ritual and mysticism.

Grotesque shadows move across the whitewashed patio walls as the men of the village gather about candle-lit tables to spend the night together, pray, visit, feast at midnight and wait for the dawn. It is the time to sow corn, and at daybreak seven handfuls of corn are placed in the center of the field in the shape of a cross pointing in the four directions of the world. Following this ceremony the villagers sow the fields.

But this is a dry year and the Chac must be called upon to tip their gourds to send life-giving water. The ceremony is attended by all the men of the village who must leave their families and sleep in hammocks strung on trees outside the village. Virgin water for the preparation of food is brought from the sacred cenote where women are forbidden. For two days the initial ceremonies continue. And early on the third day the *shaman* prepares gourds of *balche* (a mead drink) for Chac and the guardians of the *milpas*, or cornfields. Aided by four assistants, the *shaman* also presents the *balche* to the assembled men, each of whom drinks a little to remove evil from his heart. More *balche* is poured several times down the throats of a number of captive birds which are then killed as offerings to Chac. Thirteen times *balche* is poured upon the altar for the rain gods, and each



The curved nose at the corner of a temple in Kabah, Yucatan, identifies the profile of the chief Chac, the rain god. Gretchen Sibley, photographer

time the assembled men also drink. And so the morning continues until the high point of the ceremony beginning at noon.

The altar is square, with a boy tied by his right leg to each corner. The boys represent frogs, the musicians and attendants of Chac and probably the sons of the Chief Chac since they were the sons of his wife; Mayan mythology is not clear on this point. Throughout the ceremony the young boys croak in imitation of the frogs, presumably announcing the coming of rain. An older man of the village is chosen to impersonate the Chief Chac, which he does in a clearing near the altar, brandishing a wooden knife to produce lightning, sprinkling water from a gourd for rain and uttering sounds like thunder. Sometimes there are four men representing the Chac. They stand at the corners of the altar and dance about it between offerings of *balche*.

The altar has been piled with food prepared during the morning, and throughout the long ceremony the food is offered to the gods. When sufficient time has passed for the gods to satisfy themselves, the *shaman* pours *balche* on the impersonator of Chac, the food thus loses its spiritual quality and the villagers may eat.

This ceremony was witnessed by J. Eric S. Thompson, archaeologist, in a village in the Yucatan peninsula in the nineteen-thirties. No doubt it had been repeated in different forms for hundreds of years among the Mayans and neighboring Pre-Columbian peoples and may still be held in remote villages today.

Water was held as a gift of the gods and water animals were also held in great esteem and sometimes placed on the level of the gods. Small black frogs brightened with an orange line down the back were given a special position. They were called Uo and,

as noted, were known as the musicians and companions of the Chac, and by some, as sons of the Chief Chac; thus they were lifted to the status of gods. The Uo burrow underground during the dry season after supposedly stuffing their bodies with corn. And even today the Mayan farmer is filled with religious excitement if he accidentally unearths one of the sleeping animals. The sleeping frog represents man's resistance to the evil of drought.

Perhaps because the dormant frogs were thought to be full of corn, the Aztecs used them in a special corn festival. Aztecs thought that by the use of condiments they killed the corn and it had to be brought to life every eight years. During the ceremony, a representation of the rain god sat before a body of water full of snakes and frogs. He captured the snakes with his hands and the frogs with his mouth and swallowed both.

In other ceremonies frogs were roasted, wrapped in tortillas and eaten. They were also eaten as part of the daily diet. Even today in British Honduras a young girl's hands will be rubbed with a corn-filled dormant Uo to guarantee her skill as a tortilla-maker.

Before rains come, the Uo croaks loudly and, according to legend, is summoning the Chac to tip their gourds of water to make rain. Only a little water escapes in each storm which has caused the Chac to be called the "sprinklers." If all the water from the gourds were poured out it would flood the world. An interesting tale is told of a young boy who was sent to sweep out the home of the Chac. He began by sweeping out the indignant frogs and almost flooded the world by sprinkling too much water from one of the gourds. Swords, knives or axes of the Chac are thrown to earth to create thunderstorms. Ancient stone implements

found in the earth have often been identified as axes of the Chac.

By some, it is thought the Chac live in caves guarded by frogs. Special offerings are often placed before the caves to guarantee the favor of Chac. Among the Tzotzils of Yucatan this practice still takes place at different times of the year and particularly on the Day of the Holy Cross, May 3, a day related to the coming of the rains. The people form a procession, carrying incense and branches to the caves. An alcoholic drink is consumed and fireworks set off. If either San Antonio or Chac is satisfied, the rains will come.

While the Chac were considered good, they could be bad, causing hail, floods and corn rust. At such times they were shown with skulls as heads.

The small frogs, Uo, are represented on the second of the twenty-day months of the Mayan calendar, and are often pictured with beards, probably representing rain.

Not only was water important for crops, people were born in it, washed in it for three days in a row as newborn babes, cleansed their sin in it and were washed in it at death. And the animal of the water, the frog, became a symbol of life and fertility because of his relationship with water and with corn. The frog began as an egg in the water, passed through the tadpole stage and emerged from the water as an adult. The metamorphosis of toads and frogs was well known and the tadpoles were often shown in relation to fertility.

Small replicas of clay, stone and gold were carried on the body or thrown in the waters as offerings. Designs were worked into cloth and pottery or carved into stone. Effigies and whistles in the form of frogs were buried with the dead. The frog was the living, concrete evidence of the great Chac.

Frog and toad motifs were present among other Pre-Columbian people. In northern South America the motif was used extensively as an art form in pottery, furniture, clothing, gold objects and toys, and undoubtedly figured in myths and religious symbolism. Generally these amphibians were indicative of resurrection and fertility. They foretold rain, aided in hunting, brought fire and were used for food, in medicine and as charms. At times a poison bufotenine from toads was used as a drug during religious worship, perhaps to raise man above the problems of everyday life.

Frogs and toads were well known by most ancient civilizations and often held in great respect or related to some form of worship. Early man, traveling from the Eastern Hemisphere, brought with him this reverence for toads and frogs.

Frog or toad figure used on Pre-Columbian spindle whorl. Mary Butler, artist



Tadpole designs adorn this Pre-Columbian pot. Mary Butler, artist



A frog figure appears on a glyph unial from the second 20-day period of the Mayan calendar. Mary Butler, artist



Frogs and tadpoles form a design on this Pre-Columbian pot. Mary Butler, artist



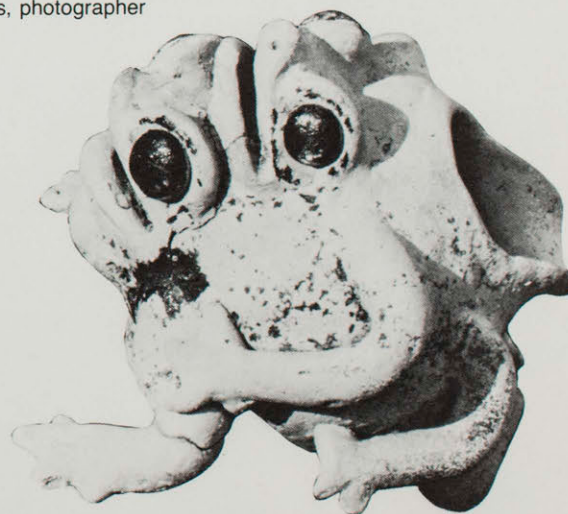
Peruvian toad ocarina. Armando Solis, photographer



Peruvian saddle vessel in the form of a frog with four snake heads. Armando Solis, photographer



This 2500 year old vessel from Mexico shows a male frog holding the female as she deposits her eggs. He throws sperm on the eggs as they emerge. Courtesy of the David Stuart Galleries. Armando Solis, photographer



Among the Northwest Indians, the frog is often on the totem pole for it indicates relationship to the frog clan, descended from the niece of the warrior who saved the Indians during the great flood. The niece married a frog and from this union sprang the frog clan. The frog is portrayed realistically with the wide mouth of a huge frog.

Evidence of frog or toad motifs can be found throughout North America. It is often difficult to differentiate between the two, but sometimes wart-like structures or designs identify toads. The mound-builders of the eastern United States constructed a large mound in the shape of these amphibians, and many bits of pottery, ornaments, beadwork and basketry bear likenesses of toads and frogs, usually of unknown symbolic value. The Cheyennes used a frog figure on their drinking cups. Hopi Indians often used tadpole decorations on their pottery. Two tribes of the Creek Indians had toad clans and practiced a toad dance. Among the Salishan tribes of the plains, it

was thought that rain was brought when frogs or toads were killed. There is also a record of the women of the tribe sometimes using toads to kill their husbands. A large black toad was hung in a tree by its legs with the mouth propped open by a stick so the poisonous juices could be collected. Some pounded the toad between rocks, collected the juice and poisoned food with it.

Even in California, in Ventura County, some evidence of the importance of the frog has been found in two ancient stone figures, one of a frog and one of a tadpole. While no real knowledge of their use is available, it seems reasonable to think they had a religious significance to early man.

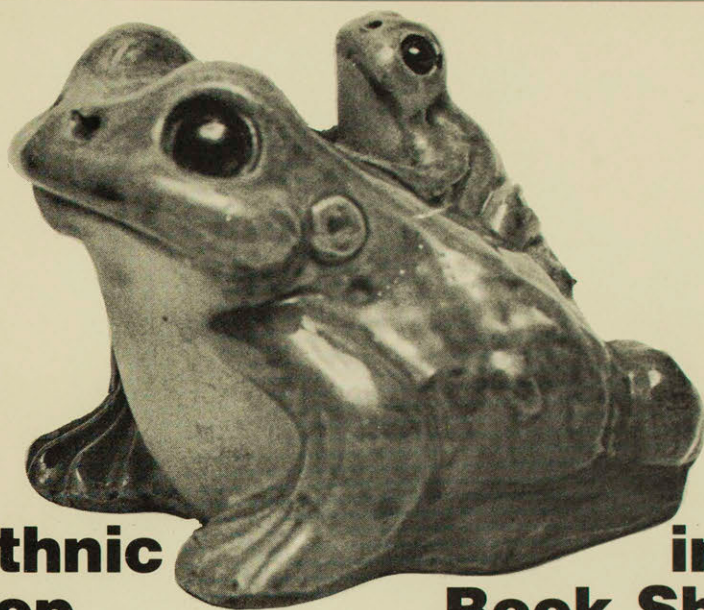
Such common creatures as toads and frogs were probably among the first animals to be revered by man. These were an early contact with nature and the mystery of metamorphosis, the development from egg to tadpole to adult, probably had a profound effect upon the mind of early man.

Gretchen Sibley writes articles, film strips and books in her spare time. She is Education Specialist at the Natural History Museum of Los Angeles County, and a TERRA assistant editor.

Small gold fertility symbols in the form of frogs are found in great abundance in Meso-america. Photo by Dr. William B. Lee



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